Adaptation to Water Scarcity in the Context of Climate Change:

A Case Study of the Nuku'alofa and Hihifo Districts, Tongatapu

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ABSTRACT

For the most part, PICs and SIDS are constantly reminded of their vulnerability to climate change. Often, the increasing portrayal of island countries as vulnerable does not necessarily address what causes that vulnerability. The UNFCCC and IPCC have sought to adopt more adaptation measures alongside mitigation especially in vulnerability assessments. In the context of Tongatapu, adaptation in the water sector still holds significant political and economic challenges.

This thesis explores the rural-urban adaptation experiences of residents in Nuku'alofa and Hihifo, Tongatapu, to water scarcity in the context of drought and climate change. It also seeks to investigate the role of vulnerability in the provision of aid, in reference to the PACC (Pacific Adaptation to Climate Change) water project in Hihifo. In utilising discourse analysis and analysis of semi-structured interviews and focus groups consisting of participants from Nuku'alofa and Hihifo, a range of themes emerged on the complexities of vulnerability and adaptation to climate change in Tonga. Hence, I sought to identify the ways that people can adapt to water scarcity in the context of drought and climate change. I draw from post structuralism, cultural geography and the vulnerability theory to uncover the discourses present in the climate change literature. It was also important to incorporate literature on sustainability and indigenous knowledge as they support better adaptation capacity in not only Tongatapu but also all of Tonga's water sector. In particular, I examine vulnerability from a local point of view versus the views of those at the national level. In doing so, local knowledges can help shape decisions on policies regarding water and climate change.

Government documents on climate change in Tonga has progressed from a vulnerability point of view to a resilience and adaptation frame of thinking. However, adaptation in the water sector is not solely a problem based on natural variability and climate change. A huge part of water problems is largely rooted on political and economic processes. This underpins the accessibility of people to water resources. This problem needs to be addressed, in order to increase the adaptive capacity of people in the rural-urban areas of Tongatapu.

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ENSO	El Niño Southern Oscillation
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter Tropical Convergence Zone
JNAP	Joint National Adaptation Plan
MECC	Ministry of Environment and Climate Change
MEIDECC	Ministry of Meteorology, Energy, Information, Disaster Management, Climate Change and Communications
NEMO	National Emergency Management Office
PACC	Pacific Adaptation to Climate Change
PICs	Pacific Island Countries
SIDS	Small Island Developing States
SPCZ	South Pacific Convergence Zone
SOPAC	The Pacific Islands Applied Geoscience Commission
SPREP	Secretariat of the Pacific Regional Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

CHAPTER ONE: INTRODUCTION

Why Water?

The climate change arena reminds us that science dominates the background for this field of study. However, given its causes are mostly due to human activity, it is essential to look at climate change from a social science point of view. Through incorporating the impact of climate change on society, we can have a sense of how the natural and human can work together to initiate better adaptation responses.

After considering the extensive range of ideas around the issue of climate change, I decided to turn my focus to water. Well, why water? The idea came to mind as I recalled the times when natural disasters (tropical cyclones) struck the island of Tongatapu, where I lived. I remembered that the groundwater (tap water) supply did not run immediately after cyclones and the feeling of having no water was indeed a problem. That was when I realised the importance of this resource and of finding ways to sustain this valuable commodity.

From what I remember, climatic disasters, particularly tropical cyclones, are always possible in the islands of Tonga due to its location. However, in the aftermath of these cyclones there is something much more challenging in dealing with water and that is the prolonged periods of drought that sometimes follow. I hear stories of people in the outer islands (other than Tongatapu) on the difficulty of coping with water scarcity in times of drought. I considered this idea as an important factor for this study, to perhaps apply the issue of water to the context of Tongatapu. Since Tongatapu relies mostly on underground sources and especially rainwater for its water supply, we need to think of ways to adapt when there is a shortage.

Importance of this study

There is no doubt that water is crucial for life. It affects all aspects of the economy and society including food security and production, domestic water supply and sanitation, energy, industry and environmental sustainability (UN Water n.d.). Climate change will not necessarily cause droughts which are often

the result of climate variabilities such as El Niño events but they may well be worsened by climate change. The climatic variability of the El Niño-Southern Oscillation is caused by natural variations in the conditions of the atmosphere and ocean (CSIRO et al. 2015).

Tongatapu is a low-lying island and it is especially important to look at ways of protecting and sustaining the water supply through utilising adaptation measures. The impacts of drought fall heavily on fresh water resources due to the low-lying feature of the island and the absence of surface water (Kuruppu 2009). Along with the increasing population, settlement in urban areas contributes to the pressure on the water supply. I question, what can be done to sustain this resource in the face of climate change? I base this study on managing fresh water supply and adapting to water scarcity in the island of Tongatapu.

Upon recognising the different perceptions of aid in water related projects, I came to think about how adaptation in the water sector has improved. Do people think of this as a way to build their adaptation capacity to water scarcity? Does this create a dependency on aid? These are some of the questions, which prompted me to look at water, and people's capacity to adapt to water scarcity and climate change. It is hoped that this study will add to the existing knowledge on urbanrural experiences on water and climate change adaptation in Tongatapu especially in contemporary times.

Background on Tonga

The Kingdom of Tonga is located in the South Pacific about 15˚ and 23˚ 30' South and 173˚ and 177˚ West (see Figure 1). It consists of 172 coral and volcanic islands and is the only remaining monarchy in the South Pacific (Tu'iafitu 2012). There are four main island groups, the Ha'apai Group, Vava'u Group, the two Niua's in the North and Tongatapu and 'Eua to the South. The main island of Tongatapu is the focus of this study and is where which the majority of the population resides.

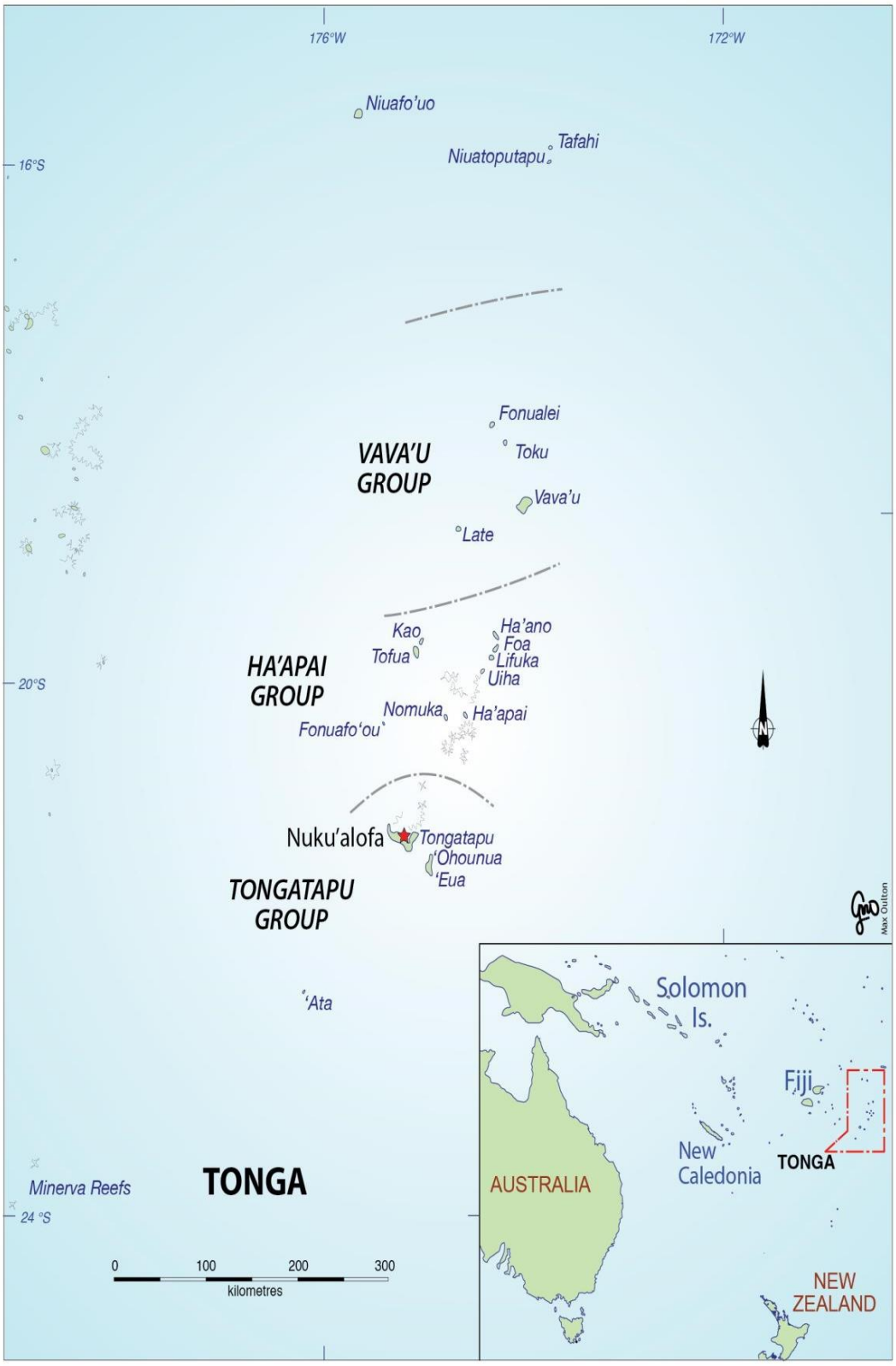


Figure 1. Map of Tonga

(Source: Max Oulton, Cartography Unit, Geography Department: University of Waikato)

According to the 2011 census, the total population of Tonga consisted of 103,252 individuals (Tonga Department of Statistics and SPC 2014). The main island of Tongatapu, where the study took place, has a total population of 75,416 which accounts for about 70 percent of Tonga's total population. As is most common in other countries, urban centres are the economic hub and it is where most opportunities for work and education are located. This is especially the case in the capital Nuku'alofa, where commerce and trade take place and there is high population density and urban sprawl as a result of migration, not only within Tongatapu but also from outer islands.

Background of Nuku'alofa and Hihifo District

The Nuku'alofa area consists of three urban districts, which are Kolofo'ou, Kolomotu'a and Ma'ufanga. Over 23 percent of Tonga's total population live in the Nuku'alofa area (Tonga Department of Statistics and SPC 2014). Figure 2 below shows the map of Tongatapu locating the capital, Nuku'alofa and Hihifo highlighted in capital.

On the other hand, the Hihifo District from which five villages were chosen for this research, is located on the North-Western side of Tongatapu. The villages are Kolovai, Ha'avakatolo, 'Ahau, Kanokupolu and Ha'atafu. Although, far less populated than Nuku'alofa, the vulnerability of Hihifo's water supply is due to its location and physical features of being very low lying amongst other economic factors. In this case, I refer to the furthest district of Hihifo which is otherwise known as Kolovai District. This specific area had a total of 4076 residents in 2011 (Tonga Department of Statistics and SPC 2014).

Figure 2. Map of Tongatapu showing Nuku'alofa and Hihifo areas

(Source: Max Oulton, Cartography Unit, Geography Department: University of Waikato)

This thesis is an original contribution on the contrasting experiences of rural and urban residents with respect to water scarcity in the context of climate change in Tongatapu. In doing so, I point out the challenges people face and coping mechanisms they adopt when adapting to water scarcity particularly in times of drought. I also identify the constructive meaning of the local point of view in comparison to the government and donor agencies. It is from here that various discourses arise about the contrasting notions of power, adaptation and how they fit in with the issue of water scarcity. I argue that place has an influence on one's experience of this problem and with respect to complex debates on the sustainability of the water sector in Tonga, it is not enough to ensure the continuation of an 'adapting' Tonga. I also argue that culture plays a significant role in the sharing of water resources, which is very much a problem itself.

Taking into consideration the social aspects of water scarcity, I believe that cultural behaviours can be a setback when coping with water shortage. I also seek to understand the discourses around water and climate change and reflect upon the experiences of participants in this study. The geography of place is definitely emphasized when researching the vulnerability of a group of people in an area. I intend to point out the perceptions of aid in relation to climate change and the water sector particularly as in the case of the PACC (Pacific Adaptation to Climate Change) water project in the Hihifo District. In doing so, it will give me a better understanding of what effects this may have on residents together with their contrasting stories on this project.

The government of Tonga has made immense progress in policy-making to combat the negative impacts that climate change may have. The Tonga Climate Change Policy is one approach, including the creation of the Joint National Action Plan on Climate Change Adaptation and Disaster Risk Management. Tonga is the first country in the Pacific Region to create a plan such as this (MECC and NEMO 2010). These two documents are highly important to this study as I highlight the main discourses presented in them.

Definitions of terms used in the research

Before moving on to the research core, there are terms that need to be defined in order to fully understand what this study is about.

Climate: refers to the average pattern of weather for a particular place over a long period of time, usually 30 years or more (CSIRO *et al.* 2015 6).

Climate change: refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (IPCC 2013a). To put it simply climate change is the long-term changes in the average pattern of weather (CSIRO *et al.* 2015 8).

Climate variability: refers to the 'natural variations in climate that occur from month to month, season to season and year to year' (CSIRO *et al.* 2015 8).

El Niño: The El Niño phenomenon is known as the movement of warm sea temperatures from the Western Pacific to the Central and Eastern Pacific and it usually occurs every 3 to 7 years (Tu'iafitu 2012).

Drought: According to Mayhew (2004) drought is a continuous period of dry weather. Drought is a complex phenomenon that most people understand to be a shortage in the amount of rainfall over a long period of time. Droughts are classified into four categories; meteorological, agricultural, hydrological and socio-economic. All these types of droughts are inter-related and often come without warning (Sheffield and Wood 2012). Each type of drought is described below.

Meteorological drought – significant negative deviation from mean precipitation.

Hydrological drought – a deficit in the supply of surface and subsurface water.

Agricultural drought – a deficit in soil moisture driven by meteorological and hydrological drought reducing the supply of moisture for vegetation.

Socio-economic drought – a combination of the three types above leading to socio-economic impacts.

Figure 3 shows the timeline of how droughts evolve from meteorological to socioeconomic impacts.

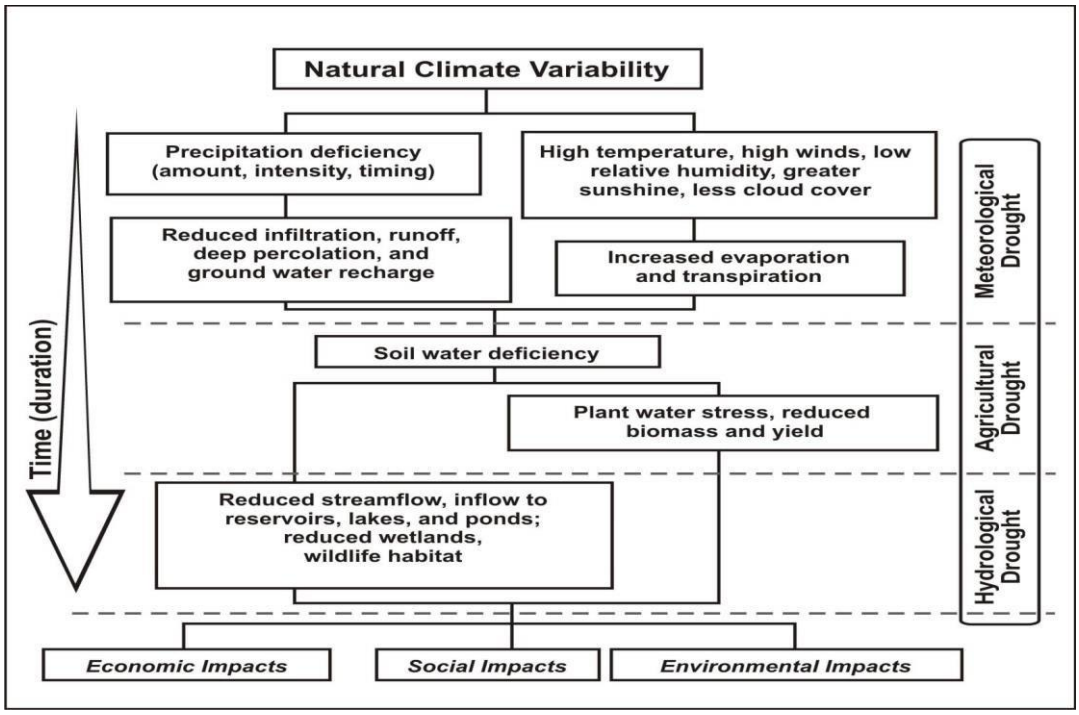


Figure 3. Timeline and impact of droughts
Source: (National Drought Mitigation Center 2017).

The diagram clearly illustrates the major types of droughts that are particularly relevant to this study. I draw from all these types of droughts especially from meteorological and agricultural droughts, and the various impacts they may have on people and the environment. Lastly, ***water resource*** here refers to the ground water and rain water which are the two main water supplies in the kingdom (Tu'iafitu 2012). ***Ground water*** or ***fresh water lenses*** are the water found below the surface of the island and floating above saline water and is replenished by rain water.

Research Questions and Objectives

The overall question guiding this research is ‘How could people adapt to water scarcity in the context of drought and climate change?’ The following are the research questions that guide this study.

1. What are the likely impacts of drought and climate change on the water resources in Tonga?
    - What is the link between climate change and water scarcity in Tongatapu?

2. What are the experiences of water scarcity of residents in the Nuku'alofa area (urban) versus the Hihifo District (rural) area of Tongatapu?
    - How have people coped with water scarcity in times of drought?
    - What challenges have they faced when adapting to water scarcity?
3. Does aid improve or discourage people's capacity to adapt to water scarcity?
4. What actions have been taken and what can be done with regards to water scarcity?
5. How do the adaptation measures in Tongatapu ensure the sustainability of the water supply?

Thesis Structure

In this chapter, I have explained the aim of this research as well as providing a brief background on the place of study. I highlight the importance of this study and that adaptation is essential for sustaining the water resources in Tonga. Adaptation is a highly-contested word in the climate change arena that has both meaning and reference to the local, national and international levels. The lack of adaptation research based on people's experiences particularly in the water sector, is something this research hopes to improve. The link between climate change and water scarcity is important as well as finding the dominant discourses around adaptation in institutional works.

In Chapter Two I set the context of this study. I provide an overview of climate change in the Pacific and discuss water resources in the Pacific Region. Climate change and agriculture in Tonga are outlined. I also present a brief background on the climatic data associated with the Nuku'alofa and Hihifo Districts in terms of rainfall and sea level in the past and present. Moving on, historical data on

droughts in Tonga are discussed as well as examining adaptation in the water sector in Tonga and other Pacific Island Countries.

In Chapter Three I draw on theoretical thoughts around three main themes: vulnerability, culture and sustainability. I discuss the range of literature that are both absent and present around this topic. I also discuss the discourse of adaptation in the climate change field and how this term displays ideas around power and knowledge.

I then explain in Chapter Four the methodology used based on qualitative research and how such research is useful in social sciences. The use of semi-structured interviews, focus groups and critical discourse analysis will be further explained in this chapter. The benefits of, and critical approach to these methods are discussed in addition to the challenges and limitations I came across when applying these methods of research.

Chapter Five outlines the findings and discussion. There are four main parts to this chapter. The first looks at the two study communities with reference to specific data on ENSO and El Niño events that have occurred in Tonga in recent years. A brief background of the study communities is outlined to provide an idea of water supply and demand in the two places. The likely impacts of climate change on the water sector in Tongatapu are also provided and the link between climate change and water scarcity in the context of droughts is explained. Hence, I discuss the role of ENSO in creating water scarcity and linking this to the experiences of participants on water scarcity or shortages in Tongatapu. The participants' worldviews are also mentioned to make sense of their life stories.

The second part looks at the individual experiences of participants and how they coped with water scarcity as well as challenges they faced in water adaptation. A section on crop production is presented here as well as health concerns over the issue of climate change on Tongatapu's water resources.

Thirdly, the responses that have been made to climate change and water scarcity in Tongatapu are thoroughly explained. More specifically, I focus on top down approaches that have taken place in recent years as well as the PACC Project that

was implemented in Hihifo. I focus on the importance of knowledge and awareness of climate change impacts on the water sector with a further study on crop adaptation. Thus, I see water and agriculture as two sectors that are of primary significance to people for their livelihoods. I also examine ways of adapting to water scarcity as well as sustaining the water supply at the household level or what is known as bottom up approaches.

Finally, I critically evaluate the vulnerability of the two study places with reference to the PACC Project in Hihifo. I seek to discover the image and role of vulnerability of people as 'victims' and the complexities of the PACC Project. In doing so, I discuss how vulnerability is addressed in policy and planning as well as identifying how climate is interpreted in the Tongan context. I highlight the importance of power and knowledge on climate change as such knowledge reflects the different views on local knowledge versus science. I show the impacts of culture on water resources in Tonga and stress the importance of expanding the way of thinking on how to adapt to crops affected by droughts in a sustainable manner. Lastly, I evaluate the usage of meters in these two areas and further examine whether water is more of a political and economic problem.

Chapter Six is the conclusion providing a summary of the main points in this study. I seek to improve what could have been done and what can be done. I argue that adaptation to climatic impacts on the water sector should be an ongoing field of research especially with regards to projects implemented in Tonga and other PICs.

CHAPTER TWO: CONTEXT

Introduction

This chapter sets the context for this study, its background as well as some facts about the historical data on the climate in Tongatapu. As the thesis unfolds, these are the climatic variables that indicate climate change in Tonga and the Pacific, including changes in sea level, temperature, rainfall and sea surface temperature. There are four main parts to this chapter that set the context for this study. The first part provides a background on Pacific Island climates as well as climate change in the Pacific region and how this has evolved over the years. The second illustrates the historical trend of tropical cyclones in the Pacific and their contribution to stress on the land and people. The third outlines the water resources in the Pacific Region and their importance. This is followed by a discussion of the climate and climate change in Tonga, agriculture and water resources and a brief description of the case study areas. Some facts on drought and tropical cyclones are provided. I also discuss adaptation to climate change in the water sector in a Tongan context which may be applicable to other Pacific Island Countries.

Pacific Island Climates

The climates in the Pacific are influenced by large scale climate features. These include the South Pacific Convergence Zone (SPCZ), Intertropical Convergence Zone (ITCZ), West Pacific Monsoon (WPM) and the two major phases of the El Niño Southern Oscillation (ENSO) which is El Niño and La Niña. The Intertropical Convergence Zone is where the North East and South East trade winds meet. It moves north and south seasonally, particularly over the Western Pacific where precipitation forms over the Western section of the ITCZ through convective activity (Rapaport 2013).

The second climatic feature, the SPCZ, is the zone where the southeast trade winds meet the southerly flow from the New Zealand region (Rapaport 2013; Vincent 1994). The West Pacific Monsoon occurs along the margins of the Asian continent, over the western central Pacific and over Northern Australia. As heat develops over Australia during the southern summer it encourages a southward

movement of the ITCZ, so the northeast trade winds are drawn southward across the equator which eventually results in a northwest monsoonal flow. This is the same in reverse in the Asian region which causes frequency of tropical cyclones in the Guam region.

The most commonly known feature of the climate in the Pacific is the El Niño Southern Oscillation (ENSO). During El Niño years, the Western Pacific experiences dry weather often resulting in droughts (MECC, 2012). Here the ITCZ and the SPCZ tend to move closer to the equator so areas near the equator experience more rainfall (CSIRO *et al.* 2015). Conversely, La Niña years bring warmer than average ocean temperatures to the Western Pacific and the ITCZ and SPCZ tend to move away from the equator. It usually brings higher than normal rainfall to the South-West Pacific. El Niño events are mostly relevant to this study.

Climate as Resource and Hazard

For the most part, the Pacific is blessed with a tropical climate which yields an abundance of food crops. It is the ideal climate for the survival of living things on land and in the sea. The Pacific climate is both a resource and hazard depending on the phase of the ENSO. Here I stress the importance of the drier climate El Niño brings (to a certain extent), particularly for tourism purposes where more people visit the region, CSIRO *et al.* (2015) and increase economic growth. In addition, the tropical climate in the Pacific is ideal for the generation of renewable energy supply in the form of solar radiation.

Despite the favourable conditions that tropical climate brings, there are times where it becomes a hazard. The occurrence of tropical cyclones in the region has increased over the years and with the influence of climate change, its intensity has also been on the rise (CSIRO *et al.* 2015). This could bring devastation to agriculture, homes, buildings, infrastructure and coastal shorelines. On the other hand, droughts decrease the water supply in most Pacific Island Countries and water conservation is an issue. This is the case in low lying atolls with limited water reserves. Islands that have higher elevation often have an abundance water reserves.

Climate Change in the Pacific

The Pacific Region is no stranger to the formidable impacts of climate change. It is one of the regions that is most exposed to the impacts of climate change, despite its low emission rates of greenhouse gases in comparison to the developed countries (Barnett and Campbell 2010). Across the Pacific, there has been an increase in the mean air temperature over the past half-century of 0.9C from 1961 to 2011 (CSIRO *et al.* 2015). Sea-surface temperature and sea level are also on the rise. Rainfall in the Pacific is influenced by a number of factors; climate processes such as the SPCZ (South Pacific Convergence Zone), ITCZ (Inter-Tropical Convergence Zone), ENSO and extreme natural events such as tropical cyclones contribute to variable rainfall patterns.

The Pacific Region has enormous differences from the developed world in terms of economic stability which makes it vulnerable to the impacts of climate change. Those in the weakest economic position are often the most vulnerable to climate change (IPCC 2007). This influences the capacity of people in the region to cope with climate change but should not become a complete stumbling block to reach full adaptation. I argue that the communities and countries of the Pacific Region have what it takes to adapt to climate change given they have been doing so for many years. Looking into the future, it will be essential to adopt other adaptation options that will enable the goal of adaptation to be achieved and in a sustainable manner, especially with regards to water scarcity.

Tropical Cyclones in the Pacific

Tropical cyclones are perhaps the most extreme natural hazards in the Pacific Region. Pacific Island people have experienced and adapted to this type of natural event since the islands were first inhabited. It has significant impacts in the region which affects the social, economic and environmental conditions in Pacific Island Countries. Tropical cyclones are formed when there is intense solar radiation heats the ocean surface causing warm, humid air to converge and rise. When this produces meso-scale convective systems (storms), air rushing into the base of the convective clouds over thousands of square kilometres may start to revolve due to the earth's rotation. As this rising air reaches the tropopause, it spirals outward

resulting in a spiral shape. This phenomenon usually occurs over summer but may happen at other times given there are favourable conditions (Rapaport 2013).

Depending on the level of exposure an island country has, tropical cyclones can cause damage to buildings, agriculture, communities and even the loss of lives (CSIRO *et al.* 2015). Future climate projection indicate that tropical cyclones may become less frequent but more intense.

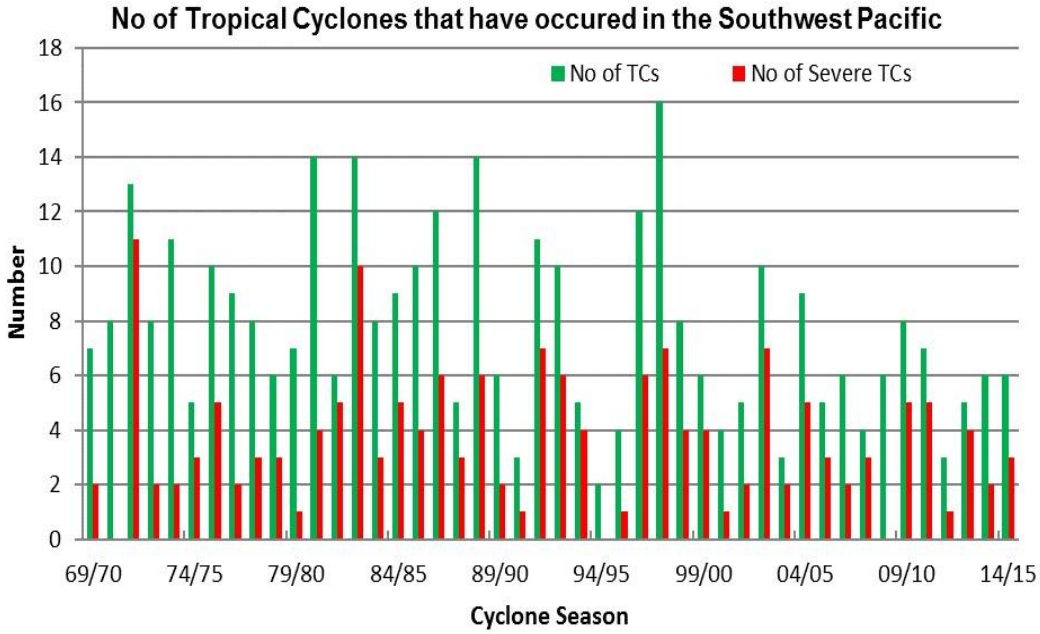


Figure 4. Observed number of tropical cyclones in Southwest Pacific
(Source: Fa'anunu 2016 22).

Figure 4 shows that between 1970 to 2015, there was a total of 347 tropical cyclones in the South West Pacific of which 165 of those were categorised as severe (Fa'anunu 2016). The Figure indicates that tropical cyclone trends are relatively stable however, there have recently been very destructive events such as Tropical Cyclone Pam (Vanuatu) in 2015 and Tropical Cyclone Winston (Fiji) in early 2016. These category 5 cyclones outlined by the New Zealand Red Cross (2014) are consistent with suggestions that cyclones are increasing.

Water Resources in the Pacific Region

Fresh water is one of human's basic needs in life. How we can manage and adapt when this resource is scarce, will ensure it is not depleted. Despite Pacific Island Countries (PIC) being surrounded by the largest ocean in the world, the supply of

fresh water resources in the region is limited (Keener *et al.* 2012,2013). Here are the main water resources found in the region.

Rainwater

Throughout the Pacific, rainwater is the most common source of fresh water used by humans. It is collected in rainwater catchments that households depend on mostly for household purposes such as drinking and cooking. The presence of ferrocement tanks are commonly found in Tonga, Tuvalu and Kiribati, Falkland (1999) which hold and store water for the family or community. It is convenient as there is greater volume and capacity of water to be stored for the dry weather season.

Ground Water

The second form of water resource is ground water which is commonly found across Pacific countries. This resource formed below sea level is one of the main water source that operates in PIC's, especially in urban areas where development and population growth are concentrated (De Freitas *et al.* 2014). The use of ground water is quite high and in order to limit the overuse of this water supply, water meters are installed in many places to address this issue as mentioned by (Falkland 1999).

Surface Water

The last source of fresh water supply for Pacific Island countries is surface water. It includes, rivers, fresh water lakes, lagoons, swamps, springs and streams. These are likely to be found in higher islands as low coral atolls generally do not have surface water (Falkland 1999). Water resources in Pacific Island Countries are very fragile, due to various reasons including their small size, the lack of natural storage, competing land use and their vulnerability to natural disasters. It is clear that the main cause of disturbance to fresh water resources in the Pacific is caused by human activity although natural causes are also a concern.

Unlike higher islands enjoying the abundance of water, small atolls have less water availability due to their small size and geographical characteristics. The

impact of climate change on fresh water resources in the Pacific varies because of different land areas and elevations (Keener *et al.* 2012,2013).

In many Pacific countries, including Tonga, the vulnerability of the groundwater supply is due to a number of factors. Some of the main water resource problems include the high susceptibility to normal climatic variability, occurrence of natural disasters, contamination from human settlements, over pumping of the ground water and sometimes agricultural activities (Falkland 1999). Most of these issues are centred around human activity reflecting core water problems are just as much a human cause than a natural one. The impact of sea water intrusion, and population pressure all add up to the problem. All these issues are present in Pacific Island Countries but vary according to different levels of exposure. It has become apparent that we cannot solely blame nature for the lack of water because humans have also contributed to the deterioration of this fragile resource. For example, the supply of fresh water resources is affected by factors such as leaks from main pipelines that are too old or lack regular maintenance and illegal connections to the pipelines (Falkland 1999).

Nevertheless, droughts in the Pacific have definitely and will continue, to threaten water security in the future. Most island countries in the Pacific are predicted to have a decline or a stable trend in the frequency of droughts in coming years (CSIRO *et al.* 2015). However, short term adaptation should not be treated as the end solution to droughts as drier climates brought about by ENSO and long term climate change will stress the water supply in the Pacific Region.

Key Characteristics of Tonga

Geographical Features

Tonga's geographical features vary from low lying coral islands to high volcanic islands (Tu'iafitu 2012). These features influence the availability of fresh water such as in certain parts of Tongatapu and Ha'apai. Coral islands are more likely to be exposed to saltwater intrusion than high volcanic islands as water lenses tend to be thin. The majority of islands in Tonga are coral islands which are categorised as low coral islands and raised coral islands. An example of a low

coral island is Ha'apai whereas raised coral islands include Tongatapu, 'Eua and Vava'u. The Niua's are examples of high volcanic islands.

Climate

Tonga's climate is tropical in nature with two seasons present all year round. The wet season usually runs from November to April and is commonly known as the cyclone season. It is the wet season that often has higher temperature and more rainfall (65 percent) than the dry season. The dry season which usually occurs from May to October has cooler temperatures at night and only 35 percent rainfall (Tu'iafitu 2012).

Climate Change in Tonga

Over the years, Tonga has had some changes to its climate following increased global emissions of greenhouse gases. It is projected that climate change will impact eight key sectors in Tonga; coastal areas, agriculture and food security, water resources, human health, fisheries, natural disasters, tourism and infrastructure (MECC and NEMO 2010). These are basically people's livelihoods and basic needs that will be altered as the climate changes. We can observe through sectors such as water and agriculture to give us a better understanding of the real impacts that may result from climate change. The indicators of climate change in Tonga include the increase in the average temperature, reduced rainfall, higher occurrences of heavy rainfall, increases in sea level and the rise in frequency and intensity of tropical cyclones (Tu'iafitu 2012).

Economy

Remittances dominate the economic growth of Tonga especially from relatives overseas sending money back home. Remittances account for about 50 to 60 percent of annual GDP (Tu'iafitu 2012). The sending of remittances back to the home country indicates the strong kinship bonds that are maintained even when people are away from home. A strong emphasis of the Tongan economy is focused on the primary sector which includes; agriculture, forestry and fisheries. These sectors are also the key livelihoods of the people from which most earn income and food. However, tourism is also an important sector where a lot of

emphasis is focused on Tonga's natural and historical sites and amenities as well as whale watching. These are all features that climate change can impact in the future.

Agriculture

The agricultural sector is one of the backbones to the lives and livelihoods of the Tongan people. It has valuable meanings in social, cultural and economic terms. About 50 percent of export earnings of the Kingdom come from the agricultural sector (Tu'iafitu 2012). The agriculture sector is very important to the livelihood of the Tongan people with majority of the rural population (about 77 percent) from Tongatapu to the Niua's stating that agriculture is their main source of livelihood (Tu'iafitu 2012). The harvesting of agricultural products is also utilised for functions and occasions whether in the family or community in most Tongan households.

The agricultural sector is linked to the water sector through the presence of rainfall for agricultural production. There are also links with ENSO when drier than normal climate (most commonly droughts) reduce the yields of food crops which in turn reduces economic growth and food security.

Tonga's Water Resources

Tonga is highly dependent upon its limited freshwater resource for everyday life. As such, water is essential for domestic and household use, agriculture and industry in the islands of Tonga. Tonga has two main types of water resources for consumption, rainwater and groundwater from rainfall harvesting and recharge (Tu'iafitu 2012). These water sources are highly dependent on the availability of rainfall which is seasonal. The hot wet season from November to April generally has more rainfall than the cool dry season of May to October. With the exception of climate change, climate variations such as the El Niño Southern Oscillation influence rainfall availability.

Groundwater is consumed the most in Tonga, and concern about groundwater salinity is a problem along the Western point of Tongatapu. (Refer to Figure 5 for an indication of the level of salinity in the Western side compared to the rest of

Tongatapu). The fresh water lenses are vulnerable to sea water intrusion from sea level rise which is an indicator of climate change.

Distribution of Groundwater salinity across Tongatapu

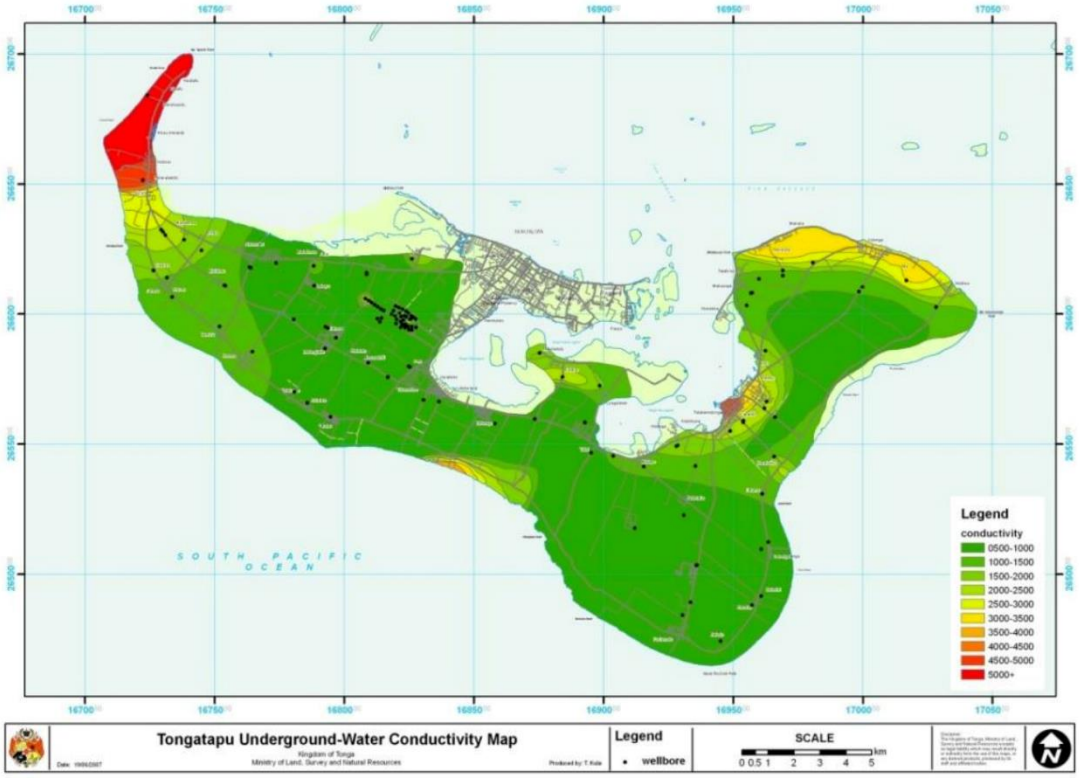


Figure 5. An overview of groundwater salinity in Tongatapu (Tu'iafitu 2012 88)

Figure 5 illustrates the salinity levels of groundwater for Tongatapu island, which may be affected by climate change in the years to come. The Western side of Tongatapu (highlighted in red) is the worst affected with very low lying land and high levels of salinity.

The Tonga Water Board (TWB) is responsible for managing water supply in the Nuku'alofa area and the urban centres of outer islands while it is the responsibility of village committees in rural areas (SOPAC 2007). The urban water supply is drawn from Mataki'eua, located south-west of Nuku'alofa where there are 36 bores that cater for the Nuku'alofa area. Of those 36 bores, 33 are run by diesel pumps and three electronically. This part of Tongatapu is metered with the exception of rural villages with having no meter at all until recently.

Case Study: Nuku'alofa and Hihifo Districts, Tongatapu

The study area included villages across the Nuku'alofa Urban area and the rural Hihifo District. Both settings have been affected by climate change differently. The Nuku'alofa area is very large in comparison to Hihifo and it is divided into Kolofo'ou, Kolomotu'a and Ma'ufanga which all make up the Nuku'alofa area.

According to the Tonga Department of Statistics and SPC (2014), there were a total of 24,229 people residing in the Nuku'alofa area in 2011. Capitals in Pacific island countries are often located where there is sufficient water supply. Increasing migration from outer islands and within Tongatapu to urban areas in Nuku'alofa. This has meant that settlement is increasing in low-lying areas along the coast and lagoon side of Nuku'alofa exposing people to harm from storm surge and sea level rise. Nuku'alofa is quite low lying especially along the Northshore and an increase of 0.3 to 1 meter of mean sea level would result in a total land area of 3.1 to 10.3km^2 or 1.1 and 3.9 percent of the island is lost (Mimura 1999).

The Hihifo District or specifically the Kolovai area is located on the Western most side of Tongatapu and includes the villages from Fo'ui to Ha'atafu with a total population of 2368 (Tonga Department of Statistics and SPC 2014). This side of Tongatapu is exposed to coastal erosion and sea inundation from storm surge and sea level rise. It is very low lying with land less than five meters above sea level. Saline intrusion to the ground water is most prominent on this side of the island
(MECC and NEMO 2010). Hihifo's water supply is supplied from inland sources as extracting water within the district is not ideal due to saltwater intrusion.

Rainfall Trends for Tongatapu

Rainfall is extremely important for the water supply in Tongatapu. The amount of rainfall that falls on land determines the supply of water in Tongatapu for both tanks and groundwater. Such rainfall availability is influenced by the climatic phases of the El Niño Southern Oscillation (ENSO), the Intertropical Convergence Zone (ITCZ) and South Pacific Convergence Zone (SPCZ). The shifts and changes in the intensity of the ITCZ and SPCZ determine the amount of rainfall over Pacific countries. The SPCZ movement greatly influences rainfall

in Tongatapu, with wetter conditions in the South West Pacific since the 1990s caused by the SPCZ moving south-west (CSIRO *et al.* 2015). In the case of ENSO, rainfall can be higher or at a lower rate depending if it is a El Niño or La Niña event. Figure 6 indicates the rainfall trends for Tongatapu island.

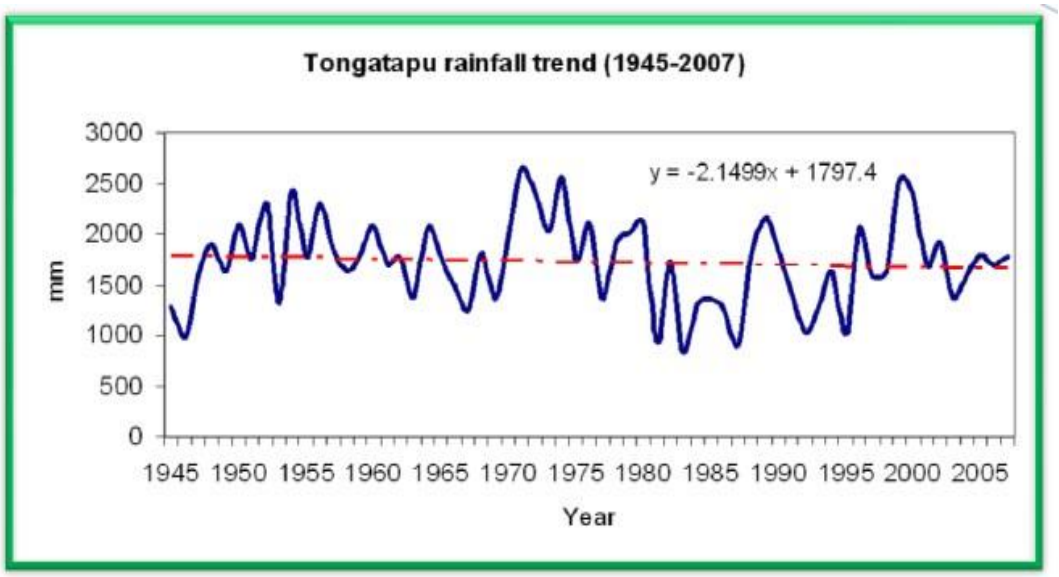


Figure 6. Observed rainfall trend for Tongatapu, 1945-2007 (MECC and NEMO 2012 75)

Figure 6 indicates a fluctuation in the trend of rainfall from 1945 to the 1950's showing an increase in the amount of precipitation on land. The deviation from the mean is highly influenced by the El Niño events and droughts in the years 1982-1983, 1997-1998 and 2006-2007. Less rainfall will mean increased exposure to droughts, stress on agriculture and primary industries and less water recharge to aquifers. A wetter climate will mean more rainfall, increased water recharge in aquifers and less stress on agriculture (CSIRO *et al.* 2015).

Temperature Trend for Tongatapu

Temperature observations are important for Tongatapu due to the influence it has on water demand, health and other sectors. According to CSIRO *et al.* (2015), Tonga experiences a maximum air temperature range from winter to summer of more than 6 degree Celsius. It is also predicted that the temperature trend will increase in the future. (Refer to Figure 7).

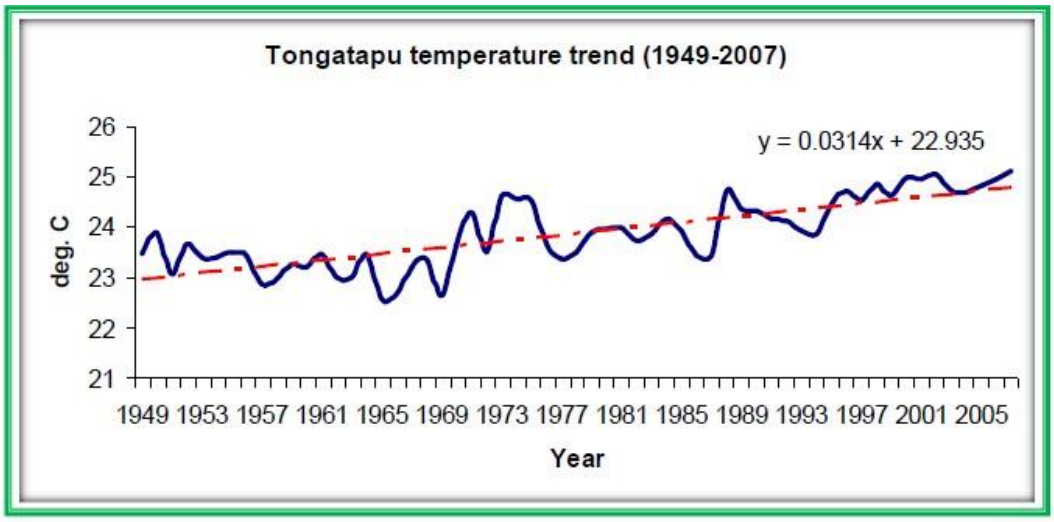


Figure 7. Observed temperature trend for Tongatapu, 1949-2007 (MECC and NEMO 79)

Figure 7 illustrates the rise in temperature in Tongatapu from 1949 to 2007. We can see in relation to Figure 6 that the higher the amount of rainfall the higher the temperature. It is noticeable in the years 1960s to 1970s, 1975-1978, 1982-1983 and 1990-1994. The implications of a temperature increase include increases in water demand for agriculture, domestic and industrial purposes, more stress on agriculture production, increases in vector-borne disease such as dengue fever and Chikungunya disease. In addition is the risk of coral bleaching (CSIRO *et al.* 2015).

Sea level trends for Nuku'alofa

The sea level trends for Tongatapu have a significant influence in altering groundwater quality. It is highly influenced by ENSO as well as tropical cyclones. When El Niño occurs, the trade winds are weakened which reduces the sea level in the west and increases in the east. In the event of a La Niña, strengthened trade winds cause higher than normal sea levels in the western tropical pacific and lower than normal in the east. On the other hand, tropical cyclones produce an increase in sea level in the short term due to storm surges (CSIRO *et al.* 2015).

Figure 8 shows the sea level trend for Nuku'alofa since 1993.

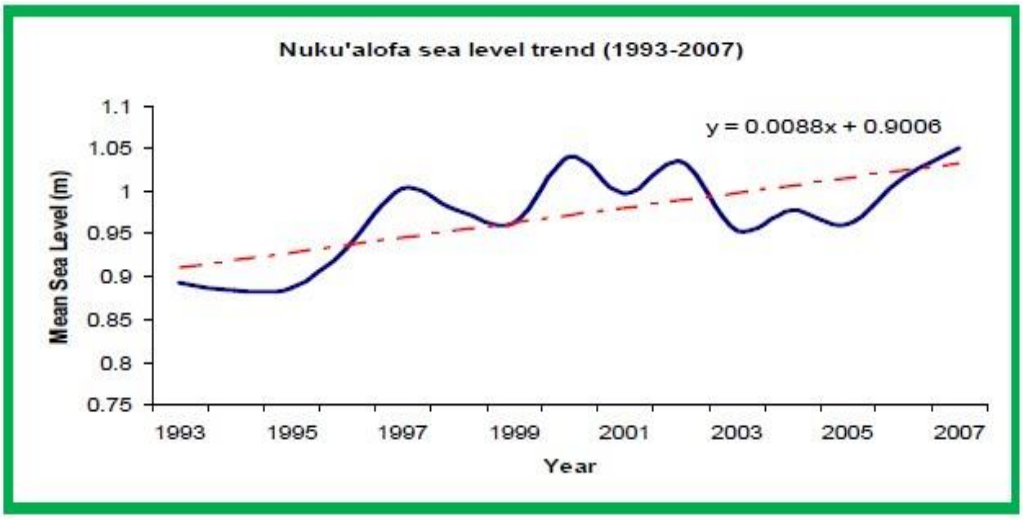


Figure 8. Observed sea level trend in Tonga, 1993-2007. (MECC and NEMO 2012)

There are a number of consequences of sea level rise in a Pacific Island context including increased exposure of islands to coastal erosion, coastal inundation and saltwater intrusion of groundwater from aquifers overtopped by seawater. Saline intrusion may also damage fertile soil for agriculture (CSIRO *et al.* 2015).

Tropical Cyclones in Tonga

Tonga is prone to the impacts of tropical cyclones occurring around November to April in the wet season. Strongly influenced by the ENSO it is within El Niño years that Tonga experiences cyclones more frequently at 1.64 cyclones per season (Fa'anunu 2016). About 73 tropical cyclones have passed Tonga in the years 1970 to 2015 and 24 of those (32 per cent) were classified as severe tropical cyclones.

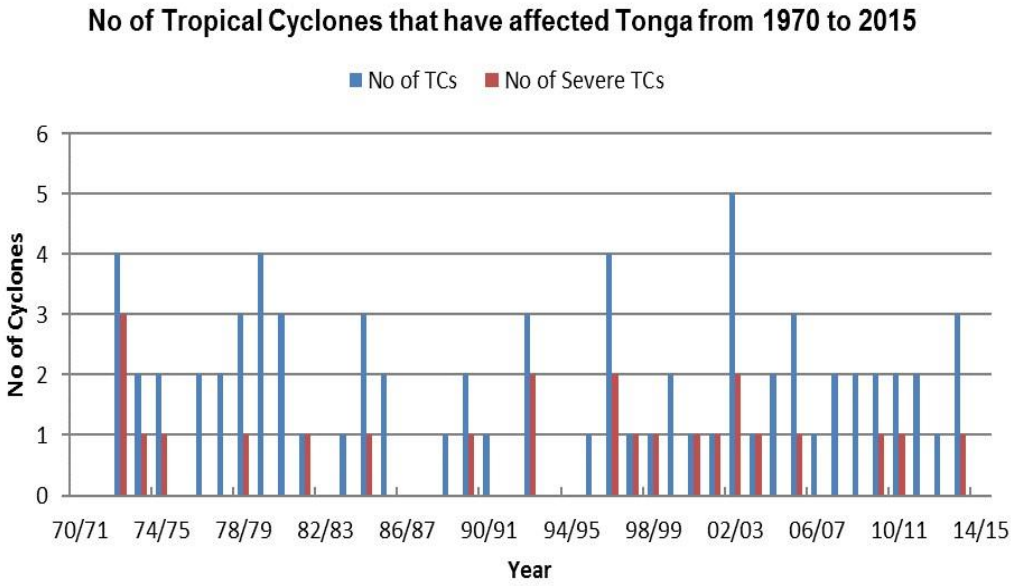


Figure 9. Number of tropical cyclones in Tongan waters. (Fa'anunu 2016 23)

Figure 9 indicates more frequent occurrence of tropical cyclones as well as severe tropical cyclones from 1996 to the present with the recent severe cyclone Ian in early 2014. The impacts from tropical cyclones include damages to homes, agriculture and infrastructure which are the same as the impacts mentioned before on tropical cyclones in the Pacific.

Drought in Tonga

Droughts have been experienced relatively frequently in Tonga in the past with the last three major droughts occurring in the years 1983, 1998 and 2006. The occurrence of the 2006 drought has to do with the El Niño events from September 2006 to January 2007 (Tu'iafitu 2012). The two sectors influenced heavily by droughts are water and agriculture through shortages in the water supply and stunted growth in root crops. This causes stress on food security and the economy through the decline in agricultural production. Other affected sectors include public health due to the lack of nutritious crop food supply, and in particular diarrhoea, skin diseases and respiratory diseases (MECC and NEMO 2010).

Adaptation in the Water Sector

Adaptation in the water sector is something that has been practiced over many years in the Pacific context. The importance of looking into this matter is because

climate change will increase the use of ground water, while at the same time reducing the supply in the future (Ludwig *et al.* 2009). Throughout the Pacific storage of water is a form of adaptation. The most common methods are storage of rainwater in cement tanks as well as large containers outside the house. The importance of traditional ecological knowledge is emphasized here and is key to the long-term adaptation capacity of people especially in the Pacific. According to McMillen *et al.* (2014), indigenous local knowledge is the practices and knowledge of Pacific Islanders in the past suggesting an adaptive capacity relevant to addressing social-ecological effects of climate change now and in the future.

There are many adaptation options concerning water in Tongatapu which can be applicable to the outer islands and Pacific Island Countries. The idea to keep in mind is that climate change is not the sole reason responsible for water stress which is also caused by human activity and population growth (Tu'iafitu 2012). The two main approaches to water adaptation are; managing the current water resource and second is providing additional water resources for utilisation.

As mentioned, one of the popular and common ways of water conservation and storage in Tonga is the use of ferrocement tanks (Falkland 1999). Another is the usage of meters to decrease water demand through the use of pricing policy. This is the case in Tonga in the urban areas, and has further reached the rural villages in recent years. Although such measures lean towards a conservation side of the water sector, whether directly or indirectly, they are also forms of water adaptation to climatic variability and more so climate change. Other methods include desalination of sea water into fresh water especially after tropical cyclones such as the aftermath of cyclone Ian in Ha'apai, New Zealand Red Cross (2014) but the method has been unfavourable due to its cost.

Hay and Mimura (2006) stress the importance of governmental institutions in enabling suitable conditions for adaptation. People will most likely adhere to institutional policies as they represent reliable knowledge and experience in the field. In Tonga, MECC and NEMO (2010) also outline the adaptation options in the water sector based on the likely impacts climate change may have on them. The Joint National Action Plan on Climate Change Adaptation and Disaster Risk

Management 2010-2015, seeks to improve the capacity to monitor water quality and to inform better utilization of water resources.

Following up institutional policy is utilizing information as one of the adaptation options to water problems. The collection of meteorological data is crucial to adaptation in the water sector in the islands of Tonga. The records of rainfall and climate projections help inform people about future possibilities in addition to weather forecasts that are announced daily to the public. Here, the science and local knowledge improves adaptation in the water sector.

Table 1 below is a list of adaptation options in these two sectors that I have selected from the Joint National Action Plan on Climate Change and Disaster Risk Management Plan 2010. I base this study primarily on water and more so on agriculture incorporating the interconnection of these two sectors in the Tongan context. Sea level rise and drought are two of the many factors that affect water supply and that is influenced by climate change. Domestic water consumption and agriculture are two of the basic needs in the Tongan household. Water and agriculture are also interconnected as agriculture cannot survive without water. The adaptation options presented in Table 1 are beneficial as majority of them are not expensive in nature and rather involve a change of attitude to how water is used.

Table 1. Adaptation options to address the impacts of sea level rise and drought on water and agriculture resources.

Climate Change and Non-climate change factor	**Vulnerable Sectors**	**Impacts**	**Adaptation Options**
Sea level rise	Water Resources	Saltwater intrusion into underground aquifers	Increase freshwater harvesting
		Increase of salt concentrations so limited supply of potable water for drinking purposes	Sustainable use of water
			Survey of underground water
			Water wells as alternative source
	Agriculture	Salt spray on crops	Move farming inland
Drought	Water Resources	Water Shortages	Expand water collection systems
		Contaminated Water	Clean water tanks
		Housing Guttering needs improvement	Monitor water usage (use water wisely)
		Dirty water	Increase number of water tanks
		Salty water	Install solar pump on ground water
			Plant more coconuts for drinking
			Wise use of water machines
			Boil drinking water
	Agriculture	Crop Destruction	Plant drought tolerant crops
		Poor yield and food shortages	Grow more fruit bearing trees
		Water Scarcity	Expand water collection system
		Mortality of crops	Irrigation
		Lack of food	Plant more crops
		Lack of food for livestock	Wise use of food
			Stop allowing animals to roam freely

(Source: Joint National Action Plan, MECC and NEMO 2010).

Lastly, I agree with White and Falkland (2010) that small islands that are independent and not part of developed countries are not likely to be better serviced than islands that are part of developed nations. This is true in terms of Tonga as an independent island nation that relies on funding of projects or overseas donors to finance such projects. Since it has a small economy, Tonga becomes dependent on foreign countries to provide assistance in providing clean safe water such as PACC. However, this does not limit what individuals and communities can do to ensure their water supplies are clean and safe. The local government and local agencies are also making an effort to improve awareness on conserving water supplies and ensuring the health of the public is a priority in dealing with water-borne deceases.

CHAPTER THREE: THEORY AND LITERATURE REVIEW

Introduction

Increasingly, studies on climate change have started to emerge, especially since the 1980's when it was recognised by academics as being likely to have a harmful effect on planet earth. The literature on climate change has greatly broadened its horizons from the physical science of climate change to incorporate interests in the human dimensions of the problem (Robinson *et al.* 2006). It is in this context that human geography has become influential in this field of study.

This chapter outlines the theoretical stance of this research. I first outline the meaning of climate change and give a brief background on climate change in general (global) and the Pacific. I discuss the concepts of mitigation and adaptation, which are highly represented in climate change literature. Then I discuss what actions have been taken to address climate change impacts in the global and Pacific Island contexts. Furthermore, I discuss the theory of vulnerability and the relevance of this concept in the context of climate change and Pacific Island Countries. I show the connection between vulnerability and climate change and how vulnerability calls for adaptation options in the water sector. The discourse around vulnerability and adaptation to climate change in the Pacific is also expanded. I tease out the role of power relations in the literature on climate change and how this vulnerability is framed in the climate change literature.

I also incorporate the relevance of cultural geography to this study, highlighting the vital role culture plays in the context of adapting to potential climate change impacts. In particular, I refer to the Tongan cultural context and link this to the literature on climate change as well as utilizing post structural theory to reveal discourses that dominate the issue. I then turn to studies on indigenous and local knowledge or traditional ecological knowledge in agriculture and conservation of resources in the Pacific to pinpoint the resilience of the agriculture sector with regards to climate change.

I examine the literature on sustainability and how adaptation could potentially ensure that water resources in Tonga are used at 'sustainable' levels. Lastly, the

chapter concludes with the challenges for successful climate governance in the Pacific.

Climate Change

What is climate change?

The term climate change tends to have various meanings associated with natural and human causes. The definition provided by IPCC (2013a) on climate change in Chapter One is based on statistical measures without indicating the input of human activity on greenhouse gas emissions. Other definitions include that of the UNFCCC (1992) states that climate change is a change of the climate which is attributed directly or indirectly to human activity that alters the structure of the global atmosphere, in addition to natural climate variability observed over comparable time periods. Therefore, the UNFCCC's definition takes into account human induced activities and showing the social side of climate change.

Climate change is considered a global issue that owes much of its cause to the increase in emission of greenhouse gases present in the atmosphere. Increases in major greenhouse gases of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) all contribute to global climate change (IPCC 2013a).

Responding to Climate Change

Because climate change is likely to have serious effects for people and environments, a range of responses to the problem have been proposed. There are two main categories of such responses: mitigation and adaptation.

What is mitigation?

The UNFCCC has been supporting the mitigation of greenhouse gas emissions since it was established in 1992. According to the IPCC (2014), climate change mitigation is the human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Although Tonga, and specifically Tongatapu, has contributed far less to the emissions of greenhouse gases, mitigation measures and activities are still essential to reduce greenhouse gases. At the global scale, climate change

mitigation takes place in seven key sectors; energy, transport, buildings, industry, agriculture, forestry and waste (IPCC 2007). What these sectors have in common is fossil fuel combustion and or destruction of sinks. Transport has proved to be one of the leading causes of CO_2 emissions. In fact, fossil fuel combustion from the transport sector accounts for 23 percent of global emissions (UNFCCC 2016). A range of mitigation activities includes the promotion of low carbon transport, efficiency of public transports and increasing energy efficiency of vehicles.

The idea of mitigation need not be limited to industrialised countries even though PICs and SIDS contribute very little to greenhouse gas emissions. In implementing mitigation measures in Tongatapu and other PICs, there is less emphasis on who is to blame for the high level of emissions. Rather, they seek to shift the focus to being exemplary figures to encourage countries emitting large amounts of greenhouse gas to reduce their greenhouse gas emissions as well. Of course, such an idea does not necessary do justice to small island societies, but playing the blame game does not address mitigation and it has to start somewhere. Thus, mitigation activities that Tongatapu, PICs and SIDS could implement include afforestation and planting mangroves on the shoreline, implementing renewable energy including the use of solar power, and promoting fuel-efficient vehicles. These are just a few of the measures that have occurred in the Pacific including Tongatapu.

Adger *et al.* (2003) state that all societies need to learn to cope with the changes that are predicted – warmer temperatures, drier soils, changes in weather extremes and rising sea levels. Studies in cultural ecology point out the risk of possible negative perceptions about one or the other (mitigation or adaptation). The nature/culture binary tends to inform mitigation/adaptation. Mitigation is seen as long term and adaptation is short term therefore seeing them as separate entities. This is reflected in the classification of mitigation as a top-down approach favouring national governments and the international community. Conversely, adaptation is seen as a bottom-up approach where the focus is on the individual and local communities (Garnaut 2008; Head 2010).

What is adaptation?

The Fifth Assessment Report (AR5) of the IPCC defines adaptation as the process of adjustment to actual or expected climate and its effects (IPCC 2014). There are many forms of adaptation. However, the two forms of adaptation I wish to stress here are *anticipatory adaptation* and *responsive adaptation*. Anticipatory adaptation involves looking into the future by addressing emerging and unknown problems. Cannon and Muller-Mahn (2010) claim anticipatory adaptation can face many challenges because it involves a high degree of risk. The uncertainty associated with this adaptation approach implies that adaptation may not be successful and often difficult to implement. Responsive adaptation is when people especially farmers react to changes in the weather they experience by changing planting times, crop varieties and so forth (Cannon and Muller-Mahn 2010). Such an adaptation response is primarily focused on the short term and is often the one that most communities are mostly likely to adopt.

There are many adaptation activities tied to specific sectors in the society. These adaptation activities differ between industrialised countries and in developing countries due to the different priorities and levels of exposure to climate variability and change. Developed countries may consider energy and transport as the most pressing sectors in which to implement mitigation measures. However, this differs from PICs and SIDS who may prioritise adaptation in the sectors of water and agriculture, which challenges the sustainability of their livelihoods and basic needs. I stress the importance of continual adaptation, especially in the long term to ensure better water security.

However, to some academics such as Burton (1997), adaptation is not solely enough to avoid the serious effects of climate change but nevertheless, can reduce the damage. Adaptation may also pose a threat in poor countries in terms of development, Cannon and Muller-Mahn (2010) due to financial constraints. Adaptation on the basis of development and economic growth often implies that development aims to help reduce poverty and enhance livelihoods whilst economic growth results in increased greenhouse gas emission (Cannon and Muller-Mahn 2010).

Adaptation to climate change especially in the long term may be difficult to fulfil due to the uncertainty of scientific climatic prediction. According to Barnett (2001) uncertainty is the imperfect knowledge of an events probability, magnitude, timing and location. The way to address this is to consider the level of certainty such as moderate to high certainty of events that are likely to happen in the future. That is where adaptation strategies can be pursued with confidence in the effectiveness of the response strategy (Homer-Dixon 2010).

Urban vs rural adaptation to water resource issues

In the context of Pacific Island Countries, the urban and the rural areas adapt differently to water scarcity and water issues. The characteristics of each setting influences the availability and accessibility of water resources for its population. In urban areas, the increase in population growth of urban centres contribute to the pressure on the water supply while water is mainly supplied for farming and irrigation in the rural context (Rapaport 2013). It may seem that the urban areas need more of the water supply than the rural however, Rapaport (2013) claims that the rural setting requires much of its domestic water in the Pacific.

The scarcity of water resources is due to three key elements. Homer-Dixon (2010) identifies these elements when the supply of the resource declines, there is increase demand for the resource and a change in the relative access of different groups to the resource. For the most part of this study, I lean towards the supply side of water resources in Tonga but also recognising the effects of water demand and climatic changes on water availability.

A community based adaptation framework has significant links with local scale adaptation. Reid *et al.* (2009 13) define community based adaptation to climate change as taking into account 'communities' priorities, needs, knowledge and capabilities which should empower people to plan for and cope with the impacts of climate change'. Reid *et al.* (2009) also, emphasise that community based adaptation is a process and not just outcomes. Although community based adaptation is more aligned with a bottom up approach, it still needs top-down approaches if adaptation is needed to be mainstreamed into government policies.

Top-down approach

The top down approach refers to adaptation activities implemented by government agencies. Van Aalst *et al.* (2008) argue that this approach has its focus on future climate. Otherwise known as the national policy level, it is the where decisions are being made in the national level about adaptation measures. This approach highly favours science in carrying out quantitative assessments and climate change projections. Bhave *et al.* (2014) implies that it actually helps to categorise uncertainty in climate projections and models. However, such approaches often fail to take into account local needs and circumstances and are often not accepted by the communities they are intended to help.

Bottom-up approach

The bottom-up approach with reference to climate change assessments involves the local community. Anyone in the community, such as local stakeholders be they a group or a town officer in the context of Tonga contribute to the well-being of that society. This approach is very much associated with adaptation strategies as actions of change that take place in the local scale. The advantage of this approach is that adaptation strategies, policies and measures are based on actual experience at different scales (Van Aalst *et al.* 2008). The bottom-up approach informs this study given that people's experiences of water scarcity in the past, the present and expectations into the future are important when selecting adaptation options.

Although adaptation needs to be considered, mitigation is still an important part of addressing climate change impacts. My question then is, 'Is this shift trying to move the focus from high emissions in the developed countries so the rest of the world can adapt to the impacts?'. However, because mitigation has not been adequate to date, adaptation has become increasingly important. Van Aalst *et al.* (2008) reiterate that attention has increasingly focused on how to cope with changing climate and to give adaptation a more central role in the international response to climate change.

Response to climate change in the global level

There has been increasing recognition of climate change impacts at the international level and ways to address the problem. Since 1992, with the establishment of the United Nations Framework Convention on Climate Change, member countries of the treaty responded to climate change impacts through the lens of mitigation. They sought to limit the average global temperature increases and the resulting climate change and coping with the impacts that were inevitable (UNFCCC 1992). This led to the creation of the Kyoto Protocol in Japan 1997, UNFCCC (1998) which had a major focus on binding emission targets for industrialised member countries due to the fact that they emit larger greenhouse gas emissions. The latest international agreement on climate change held in Paris 2015 imposed an aim to keep the global temperature rise of this century well below 2 degrees celcius and to pursue efforts to limit the temperature increase to a further 1.5 degree celcius (UNFCCC 2015). To date there have been 117 parties that have ratified the Paris Agreement out of the 197 parties to the Convention.

The IPCC has provided scientific assessments concerning climate change since its establishment in 1988 (IPCC 2013b). It has been heavily influential for government decision making and policy makers. There has been increasing recognition of adaptation responses incorporated into Vulnerability Assessments in its Fourth Assessment Report (IPCC 2014).

In Marrakech 2001, National Adaptation Programmes of Action or (NAPAs) were established by UNFCCC parties to help Least Developed Countries (LDC) identify priority activities to address their urgent and immediate adaptation needs at the national level. These plans enabled LDCs to apply for funding through the Global Environment Facility (UNFCCC 2016). This has proven useful for Pacific Island Countries.

Response to climate change in the Pacific Region

Climate is changing. The situation is serious. It is now time for action.
(The Polynesian P.A.C.T. Taputapuatea Declaration on Climate Change 2015)

Despite the low emission of greenhouse gas in the Pacific compared to the developed countries, the Pacific Region nevertheless has taken actions and responded to climate change impacts. The Polynesian P.A.C.T. Taputapuatea Declaration on Climate Change (2015) recognises the threats that climate change has on the Pacific with regards to the ocean, land environment as well as Pacific livelihoods. The Polynesian Leaders Group has urged the international community to recognize their specific vulnerabilities to climate change and to wish the Parties of the UNFCCC that emit greenhouse gas to implement ambitious mitigation measures urgently. It was also acknowledged that financial help was needed so that adaption could be better implemented.

Recently, there have been more action oriented adaptation responses to climate change impacts in the Pacific region. Tonga initiated the development of a Joint National Action Plan (JNAP) on Climate Change Adaptation and Disaster Risk Management 2010-2015 (MECC and NEMO 2010). The plan outlines a range of adaptation options in key areas that were identified as 'vulnerable' in Tonga; coastal areas, water resources, fisheries, human health, forestry, agriculture and housing. It also incorporated community consultations for the local voices to be heard, emphasising the importance of the bottom up approach in assisting topdown approaches for successful adaptation. The ongoing preparation for the next JNAP shows the commitment to fully implementing future adaptation responses. Furthermore, the climate change policy in Tonga aims to achieve a 'resilient Tonga' by 2035. The policy has relevant links with the Polynesian Leaders Group Taputapuatea Declaration in recognising the threats of climate change and raising the voice of the Pacific during COP21 in Paris 2015 (MEIDECC 2016).

SPREP (2005) endorsed the Pacific Islands Framework for Action on Climate Change for the years 2006 to 2015 particularly at the national and regional levels. One of the expected outcomes of this plan is implementing adaptation measures

in which SPREP plays a major role in maintaining the links between regional and national projects such as the Pacific Adaptation to Climate Change Programme (PACC).

The PACC Programme in Hihifo, Tongatapu

The PACC Programme is a recent activity and the first major adaptation initiative in the Pacific Region since 2009. Its two main concerns are working to enhance adaptive capacity on the ground and driving the mainstreaming of climate risks into national development planning and activities (SPREP 2013) .

Tonga was one of the recipients of the PACC with a project in the main island of Tongatapu. The main objective was to increase the resilience of the water resources management sector and to enhance adaptive capacity of villages and communities to climate change (SPREP and MEIDECC 2015). The project provided assistance to the water sector and upgrading of the Hihifo water supply system. However, with the implementation and final phases of this project, there were lessons and recommendations that had to be learnt. Key areas of improvement were primarily observed to be governance and design issues such as the need for face to face meetings on the Water Policy and considering solar pumps and generators as effective means of reducing cost of fuel. Of central importance was community consultation and the need for their voices to be heard. This was not always an easy task when dealing with the community as mentioned by representatives of government ministries.

Vulnerability

What is vulnerability?

Vulnerability is often a confusing word due to its various definitions. According to Chambers (1989), vulnerability means defencelessness, insecurity and exposure to risk, shocks and stress or the exposure to contingencies and stress and difficulty in coping with them. The term vulnerability is often mistaken for poverty but the two are actually different. Chambers (1989) once again reveals two sides of vulnerability, one is the external side of risks, shocks and stress where the individual or household is the subject. The second is the internal side which is the lack of means to cope without damaging loss (defenceless).

Vulnerability is often linked with other terms such as exposure, sensitivity, resilience and adaptive capacity. The first two terms help explain the meaning of vulnerability while the other two focus on reducing the probability of a certain population from being vulnerable. Exposure is the nature and degree to which a system experiences environmental or socio-political stress (Burton *et al.* 1993). This characteristic of vulnerability implies that a particular location or community is sensitive to outside interference. Sensitivity is the degree to which a system is modified or affected by these external perturbations (Adger 2006).

The concept of resilience has been widely used in environmental hazard literature since the 1980s in analysing human-environmental interaction (Janssen *et al.* 2006). It is the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, capacity for self-organization and the capacity to adapt to stress and change (UN Habitat 2011). Although it originated in the field of population ecology it has been utilized by various disciplines and increasingly so in the climate change field. Resilience is very much the opposite of vulnerability which has been critiqued as being *scientistic* meaning it is claiming a scientific basis and is giving privilege to rationality (Cannon and Muller-Mahn 2010). Hence, adaptation is seen as more compatible with vulnerability as people's own rational rationalities are considered when dealing with climate change impacts. However, Cannon and Muller-Mahn (2010) implies that there may be dangers of using adaptation in regard to climate change since the majority of people who have to adapt their livelihoods may not be resilient. The UN Habitat (2011) report outlines adaptive capacity as the capacity of a system, population or individual/household to take actions that could help avoid loss and speed recovery from the impacts of climate change.

A meeting held in London 2001 consisting of climate scientists, and humanitarian relief and international development agencies highlighted that people in developing nations are not passive 'victims' (Adger *et al.* 2003). This brings me to the next part of discussion which is the social construction of vulnerability in the Pacific.

Vulnerability in the context of climate change

It has been contested in adaptation studies that vulnerability is a socially constructed phenomenon that is influenced by institutional and economic dynamics. The vulnerability of a system to climate change is determined by its exposure, physical setting and sensitivity and by its ability and opportunity to adapt to change (Adger *et al.* 2003).

On the world stage, the UNFCCC and Kyoto Protocol even mention that small island developing states are particularly vulnerable to climate change (RudiakGould 2013). Characteristics of smallness, isolation and weakness come to mind when talking about the Pacific, imposing the dominant discourses that Pacific Island Countries have lived with over a long period of time. Such discourses reflect once again the dualisms and binaries of the developed and developing world such as big/small, risk/safety, weakness/strength. While it is not to say these are necessarily wrong, I argue that this fails to acknowledge that the Pacific Islands are actually very resilient in the social context.

It is often contested that small island states do not have the resources and means to adapt to the impacts of climate change. Hau'ofa (1994) reverses this thinking to capture the true image of Pacific Island countries as people that are connected by the sea, meaning they are not small and vulnerable but part of the biggest feature on earth. Bankoff (2001) outlines the many discourses associated with tropical climates of which the Western perception largely sees as an unsafe place. Once again, the use of binaries to classify the first world from third world countries is stressed in addition to the power exercised by the 'West' on 'others' through a language of knowledge especially in the medical field. Hau'ofa (1993) is against the portrayal of islands in Oceania as small and isolated hence pointing out that Pacific people live in a large *sea of islands* rather than *islands in the sea.*

Vulnerability in the context of Pacific Island Countries

The Pacific Region is often portrayed as vulnerable, be it economically, physically or environmentally. It has been categorised as one of the vulnerable regions to the impacts of climate change. Campbell (2009) states the term vulnerable does not translate well into the languages of Pacific Island Countries

indicating it was not traditionally considered an important phenomenon. Christmann *et al.* (2014) argue that climate change related perceptions of reality may differ among societies at different places and times be it due to physical conditions and/or to cultural factors. They understand climate change as a social construction given that societies construct their specific social reality of climate change.

Culture and the New Cultural Geography

There are many scholarly works on climate change, however Hulme (2015) argues that there is a lack of work on climate and culture interactions. I incorporate culture into this research to study and to acknowledge that culture and climate change are not separate entities as they affect each other taking into account people's way of life. Culture has various meanings and post structuralist human geographers have pointed out that it is a way of thinking and knowing (Gibson and Waitt 2009). Denis and Jackson (1987 95) present various meanings of culture as "medium in which people transform the phenomena of the material world into significant symbols to which they give meanings and attach value or the medium through which change is experienced, contested and constituted". Jackson (1989) refers to culture as the level where social groups develop distinct patterns of life. All these definitions illustrate that culture is spatial, where the new cultural theory in geography understands culture as being constituted through space and *as* a space (Mitchell 2000). However, some geographers have worked with culture as an undefined term due to the confusion over its meaning (Wagner 1994).

Much influence on the turn in cultural geography was by British geographers including Jackson (1989) in the 1970s and 1980s seeking to understand the geography of culture and society as they work together to shape the experience of everyday life. This was supported by Cosgrove (1983) suggesting that it was time to develop a radical cultural geography centred on issues of power, dominance and the control of space and culture by elite groups.

Cultural geography takes into account the production and reproduction of actual places, spaces and scales and the social structures that give those places, spaces and scales meaning (Mitchell 2000). Geography as a discipline has had its say in

studies on climate and of course culture. Hulme (2008) claims that the skills and identity of a geographer are important in making sense of climate change. Here, Hulme (2008) seeks to reclaim climate from the natural sciences to treat it unambiguously as a manifestation of both nature and culture and that climate can only be understood when its physical dimensions are allowed to be interpreted by their cultural meanings.

One of the certain characteristics of Pacific Island Countries is being isolated from the rest of the developed nations. Although it imposes economic constraints on Pacific Islands due to the distance and cost of trade, it benefits culture in the region. Overton and Thaman (1999) write that it is precisely this characteristic that helps Pacific Islanders maintain their cultures from the influences of cultural norms in the West and to retreat to their own land and society when they want.

The effects of globalisation have been influential in Pacific culture predominantly since the colonisation era. The introduction of new technologies and knowledge shape people's ways of life in the islands and thus their contributions to greenhouse gas emissions although not at the rate of developed countries. Hulme (2015) supports this by, climates change due to changes of humans' way of life with their material products and emanations interacting with natural processes to further perturb the workings of the atmosphere.

There is no doubt that responses to climate change, especially in the Pacific context, are centred around culture. An example is the Water is Rising Tour involving 36 performers from Kiribati, Tuvalu and Tokelau touring the United States with the use of cultural performance (dance, music and song) to communicate with the audience about the threats of climate change (Institute of the Environment 2011). At the same time, Pacific Islanders' identities are portrayed as surviving against the face of climate change. Rudiak-Gould (2013) further support this idea in that different forms of cultural work such as visual art, myth, performance, song and the like are needed to make climate change real and believable.

Post-structuralism

Post-structuralism can be traced back to its origin in the 1960s with the movement owing credit to its key thinkers Derrida, Deleuze, Lyotard, Foucault and Kristeva. Their works had a focus on power and how it is constructed through language and knowledge. The approach has sought to resist the fixed definitions of society which I sense is relevant to this research in deconstructing ideas around vulnerability through language used in institutions of power (Williams 2014). Derrida's work on post-structuralism is beneficial to this study as it should be thought of as a deconstruction. The deconstruction of language, in this case, primarily in the climate change and vulnerability literature, can begin to uncover or should I say remind us of the power that expertise and institutional knowledge have over the literature. The attention to what is not written in texts leads cultural geographers to question why certain people, things and ideas were missing from a representation (Shurmer-Smith 2002). Hence it is important in the analysis of discourses in this study.

Williams (2014) also states that one of the key elements of post-structuralism is showing that power is not limited to such organisational understanding of power to be power over others but also the power to change oneself. Here, I agree with the idea that those who adapt to the conditions of climate change in the Pacific context shows they already have the power to reduce the exposure to such threats by changing their own sets of circumstances.

The ideas around power and knowledge are central to post-structuralism through its emphasis on discourses. Analysis of discourses around power as disciplinary power is one way that Foucault sheds light on the circulating notion of power rather than adhering to specific sites (Castree *et al.* 2013). This forms the baseline for the analysis of vulnerability as a discourse in Pacific Island Countries which I will discuss later in this chapter. In particular, Foucault turns away from the basic understanding that power is a top-down approach but rather sees power as everywhere and that we exercise power ourselves through self-regulation (Wylie 2015).

Demeritt (2002) notes from a constructivist perspective that adaptation to climate change is not simply a response to meteorological parametres but it is primarily

driven by discourses about these phenomena in a society. Hajer (1995) describes discourses to be specific groups of ideas, concepts and categorizations that are produced, reproduced and transformed in particular sets of practices. Historically, discourses in global environmental research have been produced following scientific knowledge that has been practiced by institutions (Backstrand and Lovbrand 2007). Discourses are established by groups of actors who try to gain superiority over other participants in a particular discourse by pushing or forcing the others to accept their position.

Framing Vulnerability and PICs in the context of climate change

Studies on vulnerability are largely supported by the literature on hazards as mentioned by Cutter 1996 and Cutter et al., 2000 and has sparked interests from a variety of disciplines (Janssen *et al.* 2006). There are two perspectives to vulnerability in the climate change literature: biophysical vulnerability and social vulnerability which Cutter, 1996, Klein and Nicholis 1999, Brooks 2003, Fussel 2007, identifies. Biophysical vulnerability focuses on the physical environment and the outcome of climate change impacts. This excludes the social processes that need to be taken into account when talking about vulnerability. Social vulnerability is considered to be a condition of the social system including individuals and communities. Without the first perspective, vulnerability is incomplete when analysing vulnerability in climate change issues. What is more relevant to this study is a third perspective or integrated approach to vulnerability where the first two perspectives are combined to better understand the complex processes of adaptation to climate change. The limitation with this is working with different ways of framing and performing the analysis of vulnerability (Soares and Gagnon 2012).

There are two key approaches in the framing of vulnerability in the climate change literature. Kelly and Adger (2000) highlight this as the 'end point' and 'starting-point' approaches. The first approach considers vulnerability as the end point of a series of analyses from projecting future emission trends to the development of climate scenarios, to biophysical impact studies and identifying adaptive options. This is highlighted as comparative change in which McCarthy *et al.* (2001) refer to vulnerability as including exposure, sensitivity and adaptive

capacity. The latter approach sees vulnerability as being unable to cope with external pressures or changes. An example of the first approach is mentioned by Burton *et al.* (2002) assuming that addressing present-day vulnerability will reduce vulnerability under future climate conditions. It is through current adaptation measures that people can be prepared for future climate change impacts.

Moss *et al.* (2001) have pointed out three dimensions of vulnerability which I agree are applicable to Pacific Island Countries. Firstly, the physical environmental dimension looks at the climatic conditions in a region and the biophysical impacts of climate change such as the changes in agricultural productivity. The second is socio-economic dimensions which refers to a region's capacity to recover from extreme events and adapt to change over the longer term. The last dimension is external assistance and is the degree to which a region may be assisted in its attempts to adapt to change through its allies and trading partners, diasporic communities in other regions and international arrangements to provide aid. However, others including Cutter (1996) challenge this idea regarding that the biophysical is independent from the social dimension of vulnerability.

The use of language to describe Pacific Island Countries offers critical thoughts. Pacific Island countries have often been labelled in climate change institutions as 'victims' of climate change. Even more so, Pacific Islanders refer to themselves as victims when communicating with the international community in most climate change action and policy. This term shapes the identity of Pacific Island countries as weak and vulnerable in the fight against climate change.

How natural hazards and climate change differ

Increasingly, natural hazards have come to dominate the climate change field as threats to people and the environment. This poses a problem in that the two are seen as separate entities or better yet natural hazards are portrayed as new events. Kelman (2014) also implies that climate change hazards that affect SIDS are frequently presented as being a new phenomenon. I draw from Kelman's work in that climate change hazards that affect SIDS are frequently presented as a new phenomenon.

I also draw from Fussel (2005) on the difference between natural hazards and climate change in terms of vulnerability assessment. Table 2 provides a summary of the features associated with natural hazards and climate change when conducting vulnerability assessments. Climate change may worsen natural hazard events in the years to come.

Table 2. Characteristics of the Natural Hazards and Climate Change field according to Vulnerability Assessments

	Natural Hazards	**Climate Change**
Hazard Characteristics		
Temporal	Discrete events	Long term & Continuous
Dynamics	Stationary	Non-Stationary
Spatial Scope	Regional/Local	Global but heterogeneous
Uncertainty	Low to Medium	Medium to very high
Attribution	Natural Variability	Natural & anthropogenic
Systems of Concern	Social system and built infrastructures	All systems
System View	Static	Dynamic & adaptive
Consequences	Specific Impacts	Broad range of impacts
Targets for risk reduction	Internal Vulnerability	Hazard potential and Internal Vulnerability
Analytical Purpose	Normative	Positivist and Normative

Source: (Fussel 2005 25)

Indigenous and local knowledge (Traditional Ecological Knowledge)

Traditional ecological knowledge or some would say indigenous local knowledge, has been of interest to researchers over the years since the 1980s, especially with regards to sustaining resource use (Schmink et al., 1992, Berkes 1999, Berkes *et al.* 2000). Originally beginning in the ethnobiological study of species, it has made its way towards people's understanding of ecological processes and their relationships with the environment. Berkes (1999) outlines traditional ecological knowledge as a knowledge-practice-belief complex.

Berkes *et al.* (2000 1252) define

> traditional ecological knowledge as a cumulative body of knowledge, practice and belief evolving by adaptive processes and handed down through generations by cultural transmission about the relationship of living beings (including humans) with one another and with their environment.

The Pacific Region has been resilient to natural hazards and climate variability in the past and still is in terms of traditional agricultural practices. Much of the traditional knowledge in the Pacific is tied to natural disaster preparedness of which agriculture is a key indicator of a resilient community. The potential of tropical cyclones and droughts to cause harm include wind damage, salinization, water logging, silting and moisture stress to the food crop environment (Campbell 2006). To combat these impacts, traditional knowledge brings back the high level of resilience through the production of food surpluses, controlling food consumption and using resilient crops. To maintain resilience, food security must be one of the priorities in increasing disaster resilience and agricultural practices have definitely ensured abundant food supply.

Traditional Knowledges in Agricultural Practices

Traditional knowledge in agricultural practices has proven to be critical in maintaining resilience in the Pacific. People who possess traditional knowledge have a good chance of sustaining their gardens despite natural hazards and variations in the weather. It is important to know which crops are more resilient in different types of conditions to improve agricultural resilience. The yam is a good example of staple food crops that survives when there are high winds and dry conditions (Campbell 2006). The above ground foliage might not escape the strong winds however, the root may remain unharmed. However, yams do not suit watery conditions that other crops may be suited to. Taro on the other hand is not compatible with yam when there are high winds due to the roots being stressed from the winds and the taro plant may rot because where the stem joins the root is damaged (Campbell 2006).

Clarke and Thaman (1993) point out the importance of famine foods in aiding agricultural resilience. Interestingly enough, food crops that are considered famine foods in most island countries are considered staple crops in atoll

countries such as Tuvalu and Kiribati in the production of pulaka or babai (swamp taro, cyrtosperma). However, these important practices have declined especially with more food relief supply following disasters as well as expansion of commercial cropping as in the example of Mota Lava in Northern Vanuatu (Campbell 1990).

Across the Pacific, indigenous and local knowledge has been a basic component in the lives of Pacific Island people. The ability to cultivate agricultural produce is one of the key elements of a resilient economy and country. McMillen *et al.* (2014) state indigenous local knowledge is central to understanding resilience and adaptation in the Pacific. However, others such as Johannes (2002) claim with reference to conservation, that for some Pacific Island peoples, they first had to deplete their resources before learning that the resource was limited. I argue that local knowledge is essential when considering adaptation to climate change.

Clarke and Thaman (1993) discuss the importance of food staples in the agricultural sector because they have economic and cultural value to Pacific societies. Thaman (1995) stresses the importance of house yard food gardening especially in urban areas where population growth is a growing concern. I am convinced that this idea is necessary for household food security as well as maintaining local knowledge in cultivating the land. However, problems may occur pertaining to the availability of land and water in urban areas.

My focus on indigenous and local knowledge will be based on the agricultural sector as it is the source of livelihoods for most households in Tonga. The knowledge of sustaining traditional root crops in the Pacific is remarkable. From the planning of planting, to tending the crops, and harvesting and protecting them, local knowledge has been useful in managing food resources in the Pacific. In Tongatapu, like most Pacific Islands, cropping patterns illustrate the importance of having local knowledge. However, this has changed in recent years as climate variabilities have altered the usual timeframe of planting and removing crops at certain times of the year. The cropping cycle starts with clearing secondary vegetation and the remaining dried plants are burnt in preparation for planting yams, taro and other root crops. Increasingly, commercial agriculture tends to

replace the subsistence farming of agricultural products as well as introducing new crops.

Sustainability

In the 1980s, the acknowledgement of social scientific approaches was required in understanding environmental values (Barr 2008). It was during that time that social science sub-disciplines came to life (e.g. environmental geography, environmental economics) representing a shift from the technocratic model of researching environmental issues to consider social and economic factors (Barr 2008). The term sustainability is slippery in nature meaning it has no specific definition, however for this research I will focus on sustainable development with regards to water resources in Tonga. According to the Brundtland Report definition, sustainable development is 'meeting the needs of the present without compromising the needs of future generations to meet their own needs' (World Comission on Environment and Development (WCED) 1987 41).

Indeed, the relevance of this concept to this study is something to acknowledge. Knowing that water resources in Pacific Island Countries and Small Island Developing States outside the Pacific Region are limited in supply, sustaining the resource for future generations is vital. Instilling values into the present generation can make sure that this resource does not reach the point of extreme scarcity particularly in climate change scenarios.

Sustainability has become embedded in our everyday language. It is a discourse that has underlying principles consisting of values, ethics and knowledge that guide the behaviour of individuals (Barr 2008). We come across this term quite often in our everyday life especially in supermarkets advertising products which brings forth another part of sustainability as having an economic element to it. The three popular discourses of sustainability economy, society and environment that are seen as interlinked is actually quite complex in the contemporary setting. Giddings *et al.* 1996; 2002 as cited in Barr (2008) claim that this is not the case today as economy tends to dominate environment and society.

Often, the economic approach to sustainability does lead to a change in behaviour, however it is focused on costs and benefits with higher costs leading to this

changed behaviour. I tend to be critical of this approach considering those who are rich and well off may still carry on utilising water resources wastefully because they can afford to. Hence, I question whether this is sustainable or is it the opposite of sustainability.

The concept of sustainability is of central importance even more so when everyday practices are transformed into sustainable lifestyles. With respect to water resources, Barr (2008) outlines some of the water conservation behaviours that individuals can adopt to reduce wasting of water resources. The space of the home is central to this as my research mostly focused on water adaptation and experiences in the participants' households. It involves members of the household doing their bit to conserve water through making changes to the ways they use water with regards to both in and outside the household activities.

Jacobson (1999), Lenton and Muller (2009) highlight the idea that understanding a population's beliefs in environmental issues (such as climate change) and attitudes toward conservation actions can improve communication initiatives, policy development and education. These are all necessary for effective water conservation management. According to Brownlee *et al.* (2014), there is a gap between the beliefs in climate change and water conservation attitudes within a local context. This alone is essential to this research when looking at the experiences of local communities and their attitudes towards water scarcity and whether they know climate change is happening let alone believe it.

Water Resources: Looking at the world and Pacific Island Countries

At the global level, freshwater resources are extremely small in percentage in comparison to saline water. Freshwater resources only account for three percent of the total water resource on earth, including ice located in the polar region and the rest of the 97 per cent is saline water and sea ice (Grover 2006). According to Grover (2006) earth's water resources include water from the oceans and seas, ice and snow of the polar region, mountain glaciers and water in the soil and underground layers. This implies that freshwater resources are scarce and unevenly distributed (Grover 2006). This applies at the global level and even more so in the context of Pacific Island Countries. We understand water scarcity

to be caused by lack of supply of water resources but it is also caused by the contamination of water resources.

A number of factors contribute to the deterioration of water around the world which some may also apply to Pacific Island Countries. Firstly, agriculture is the major water consuming activity throughout the world (Graedel *et al.* 2010). In addition, growing urban development and population have added to water resources becoming scarce.

Water in Pacific Island Countries consists of rainwater, groundwater and surface water (Falkland 1999). Without incorporating sustainability into water management, water resources may be worsened by climate change. This is where sustainable practices such as reusing wastewater as well as ensuring agricultural practices minimise emission of pesticides into the ground or surface water are important (Graedel *et al.* 2010).

The challenges of Climate Governance in the Pacific

The Pacific is known to work in a manner that is usually referred to as 'regionalism'. It simply means Pacific Island Countries work together as a region. The eleven regional councils known as the CROP agencies work together for the best outcome of issues in the region and is influential with regards to policy and governance (Barnett and Campbell 2010). However, as much as the term seems positive and peaceful, there are complex issues that are dealt with within these organisations.

My focus will be on one of these organisations called SPREP or the Secretariat of the Pacific Regional Environmental Programme. SPREP is the principal agency for climate change policy, projects and programmes in the region serving 21 of its member countries and territories. In this study, I focus on SPREP funding of projects especially the PACC Programmes. The conflicts between member countries and these organisations often puts pressure on these agencies whether to serve themselves or the countries. Barnett and Campbell (2010) say the problem is because of the lack of core funding to support countries in the way they want to. SPREP spends much effort seeking funds and managing projects funded by donors, the supply of which may not match the demands of countries. With

reference to this research, this organisation was mainly responsible for organising the PACC programme in the Hihifo District in Tongatapu.

According to Barnett and Campbell (2010) the quality of governance is one of the key factors when talking about the capacity to adapt. There is no doubt that ideas of smalless and financial instability come to mind when climate change projects are implemented in Pacific Island Countries. Campbell (2010) and Alley (1999) have written about the gap between declaration and implementation with regards to environmental sustainability and climate change despite having ratified various international treaties and protocols in the Pacific. The top-down approach is once again critiqued in the local level when rural communities are forced to address associated environmental problems without external guidance (Nunn *et al.* 2014).

There are several barriers to effective decision making on climate change in the Pacific. To sum up, there are three main reasons why climate change decision making may not be as successful especially in the context of Pacific rural communities. The *lack of awareness* about climate change particularly in the rural areas means people are not aware of the likely impacts and ways to adapt to environmental change. For example, a study in Vanuatu and Fiji illustrates that people make decisions about changing environments without knowing the background cause or range of adaptive responses and importantly, not understanding climate variables as long-term climate change (Nunn *et al.* 2014). *Tradition* can also act as a barrier in decision making especially in the rural places when some traditional leaders make decisions without awareness. Hook (2009) and Nunn (2009) point out that decision making structures at the traditional community level could not be replaced in the context of Pacific Islands but can be adapted through empowering traditional leaders to make informed long-term decisions about their environments. Nevertheless, the Pacific Islands Framework for Action on Climate Change has considered promoting adaptation action at the policy level (top-down) and community level (bottom-up) (SPREP 2005). Lastly, there is preference for *short term responses* in developing countries in terms of sustainable living (Nunn *et al.* 2014).

Conclusion

In conclusion, this study takes a variety of theoretical concepts when considering climate change. I acknowledge that mitigation and adaptation options are already underway in most countries and especially members of the UNFCCC. Pacific Island Countries have also taken their part in responding to the harmful threats of climate change affecting their environment, oceans and culture with the most recent agreement on COP21 in Paris 2015. I draw from vulnerability theory and its evolution from the natural hazards literature to become applicable in the study of climate change. The term has become a dominant discourse in the setting of Pacific Island Countries, sparking debates in the field by authors such as Hau'ofa, picturing the Pacific as a 'sea of islands' and not islands in the sea although his work was not in the context of climate change. More recently, vulnerability has been the foundation of adaptation studies and has appeared to be socially constructed. The brief review of the top-down and bottom-up approaches classified the top-down approach as policy and science oriented whereas the bottom-up approach was seen as community level driven.

I discussed the interaction of culture and climate change and how these two concepts are not separate entities and that they affect one another. This is represented by globalisation and humans' ways of life impacting on the natural atmosphere. The new cultural geography also saw the coming together of culture, society and space to shape everyday life. I also draw from post-structuralism to tease out the language and power discourses present in the climate change literature especially with regards to vulnerability and discussing how vulnerability is framed in PIC's and climate change. Upon recognising the importance of traditional ecological knowledge, I turn to the works of Thaman, Berkes and others and the idea of maintaining urban house yard food gardens. This practice is not uncommon in most Pacific Island Countries which is often problematic in the urban areas due to the cost and availability of water. Following that, I discuss the next concept which is sustainability. A concept portrayed in everyday life, this discourse presents complex meanings in the social, economic and environment fields. It is the practice of sustainable living at the household level that is relevant to this study and the conservation of water resources. I take

into account sustainability as a significant framework for adaptation practices and linking sustainability to water resources and climate change.

Lastly, to implement better climate change decision making at the national and community level, the top-down and bottom-up approaches need to work together to face the impacts of climate change. The criticisms will always be there but working as a team (government and communities) will ensure that each Pacific Island is prepared for its future.

CHAPTER FOUR: METHODOLOGY

Introduction

In this chapter, I discuss the research methods which were based on qualitative research. According to Bryman (2012) qualitative research is a strategy that stresses words rather than numbers in the collection of data. This gave me greater depth of insight into people's experiences and a better understanding of where they are coming from. We have to be conscious when discussing qualitative research in which numbers are not involved as this is not always the case. Bryman (2012) identifies that qualitative research does not fully reside in the absence of numbers. Thus, quantitative research is also important to qualitative research. In the context of climate change, scientific statistics and models tend to dominate the literature. Thus, I regard a quantitative approach as a significant contributor to qualitative research.

Qualitative methods have been influential in geography research in recent years. This followed the dominance of quantitative methods in the 1960s as well as the occurrence of intellectual turns in rethinking more appropriate methods (Dyck 2015). The use of qualitative research methods in geographical research reflects a growing interest in human agency and lived experiences. Qualitative research should not be seen as separate from quantitative research; rather they should be complementary (Hoggart et al. 2002). Taking into account the nature of this research and emphasizing participants' experiences, qualitative methods were more suitable for gaining insights of participants' life stories.

In what follows, I discuss the methodological framework in this research. Hence, I outline the key methods used to collect the data. I include in this discussion semi structured interviews, focus groups and documents as sources of data as well as the process of recruiting participants for the interviews and focus groups. In addition, I discuss the relevance of discourse analysis and text analysis of documents in addition to the interview and focus group analysis. Lastly, I will reflect my position as a researcher and how this has influenced this study.

Qualitative Research

Over the second half of the twentieth century, human geography has sought to incorporate a range of methods and approaches in order to give meaning to geographic research, as cited by Claval and Entrikin in (Benko and Strohmayer 2004). Qualitative methods allow the researcher to see through the eyes of the people being studied (Bryman 2012). Thus, I will be able to understand the topic from the participants' points of view as well as deriving explanations drawn from detailed answers the participants provided. However, qualitative research has its disadvantages as it is difficult to replicate as opposed to quantitative research. Not only that, but qualitative research is often subjective as the research is often based on the researcher's point of view about what is important.

I use the post-structuralist approach to inform the methods used in this study to emphasise that theory and method are interconnected. Although the methods employed have been attributed to feminist methodology they have been useful in post-structuralist and cultural geography. It was essential to use a variety of methods to obtain different viewpoints on the topic. Triangulation describes this approach very well.

Longhurst (2009) states triangulation is a technique that involves a variety of methods to collect data. This ensures that the data collected is not limited to the evidence found using one method but is based on a variety of methods or sources of data. Hence, this is why I chose to conduct semi-structured interviews and focus groups together with documents as sources of data for this study. I sense that these methods will help provide rich information on the topic and the research questions I intend to answer.

For the scope of this research, I employed two qualitative techniques in gathering information which was in oral and textual form. Although, qualitative research may seem inferior to 'real' science in the sense that qualitative is subjective while quantitative is deemed to be objective, Winchester (2000) the latter is not without problems. Such differentiation does not take into account that both methods are important to this study. Despite focusing on people's experiences, it was important that scientific facts on past and future climate projections backed up the stories people told for a more justified outcome.

Semi-structured Interviews

Semi-structured interviewing is one of several research methods that are commonly used in human geography. It is a useful method in trying to understand the complexity of human behaviour and experiences (Longhurst 2009). As this research explores people's experiences of adaptation to climate change, I saw this method as a useful tool in gathering data from interviewees, particularly in the collection of rich data on the participants' experiences especially at the household level.

Many copies of the interview schedule and consent form were prepared for the interviews. The interview schedule consisted of various questions that guided the interview and were informal in nature. I added some questions when I was unsure of issues that arose or when new information was of relevance to the topic. In order for me to understand more of the participant's knowledge I included questions that were open ended for them to answer in an unconstrained manner. In addition, as the interviewer, I ensured that the interviewees were free to discuss anything that they saw as important to the research. I audio-recorded the interviews depending on the participant in order for me to transcribe and understand their responses after the interview. Longhurst (2009) outlined that semi-structured interviews can also be time-consuming. Upon completion of the data collection, I then transcribed my interviews, the majority of participants preferred to be interviewed in Tongan. Indeed, this was challenging in the sense of translating certain words into English as some of the words can be quite confusing. An important example is weather and climate which are both referred to using the same word or phrase 'feliuliuaki e 'ea' which can mean change in the weather or change in the climate. This is problematic since weather and climate have very different meanings in English and in the context of climate change. Therefore, translating and transcribing were both time consuming but nevertheless allowed me to undertake a thorough analysis of the interviews.

I was also fortunate to interview a few government officials whose Ministries dealt with water and climate change issues. They were from MEIDECC which includes both NEMO and the Tonga Meteorological Service. The rest were from the Ministry of Environment, Tonga Water Board and the Geology Unit. The

questions were also informal in nature and focused more on the works and policies that these Ministries have completed in the field of water and climate change in Tongatapu. I managed to get a detailed description of past and current works being done on climate change which was very useful for analysis.

Focus Groups

Focus groups is a method of interviewing that usually involves several people in a group (Bryman 2012). It leans towards the discussion of ideas that are relevant to the topic that the researcher is focused on. Hoggart et al. (2002) identify the aim of focus groups as gathering people to interact about a given topic which is led by the researcher. Focus groups have common features with interviews in the sense that they are both having direct interaction between researchers and research participants (Hoggart et al. 2002). The difference between focus groups and semistructured interviews is that focus groups do not restrict communication directly to that between the researcher and a single participant as opposed to interviews. This technique is useful since participants discuss their views where some views may be supported or challenged.

At one stage in the research, I did not intend to use focus groups as I felt that the interviews already gave me the data needed and was conscious of getting the same information as the interviews. However, I decided to carry on with focus groups and see if there would be any new issues on people's experiences with water scarcity. Using focus groups to collect data opened up and reminded me of life back in Tonga when participants discussed their own experiences. Bennett (2002) emphasises the usefulness of focus groups in understanding the histories, responses and thoughts of communities in relation to particular issues.

I conducted two focus groups, one from a village in the urban areas of Nuku'alofa and one from a village in the Hihifo district Tongatapu. The reason for this was to compare people's experiences from the urban versus the rural areas and to identify what similarities and differences they have. In addition, the focus groups gave a detailed account of the PACC project in Hihifo. I am interested in finding out why the Pacific Adaptation to Climate Change programme was carried out in Hihifo as opposed to urban areas of Nuku'alofa. It was very important to audio-record the focus groups as I had to capture what everyone was saying.

Disadvantages of this method, as mentioned by Bryman (2012) include the difficulty of organizing and the difficulty of transcribing as two or more participants may speak at the same time, unlike semi-structured interviews which have a greater level of control. Both methods are time consuming. One of the drawbacks was the lack of involvement from some members in the groups. However, I insisted that there was no right or wrong answer and that I was interested in what they had to share.

Documents as Sources of Data

Documents are important sources of information especially in the context of this study. I refer to documents as anything from media and press releases, government documents and reports as well as virtual documents. Qualitative research has identified documents as useful sources for social science research (Bryman 2012). I draw from a range of reports by some of the selected government ministries as well as media and press releases on climate change and water related issues. I used the Tonga Climate Change Policy and the Second National Communication on Climate Change Report for Tonga.

I also found relevant documents on the SPREP (www.sprep.org) and SOPAC[1] (www.pacificwater.org) websites which offered various publications on climate change and water projects in the Pacific Region. I then downloaded a number of these reports in preparation for discourse analysis. After I read these documents, key words were identified using different coloured pens to highlight major themes that arose. Some reports on the PACC programme were also obtained from the websites above as well as from the Climate Change Department in Tonga. Some key elements of documents as sources of data are centred around authenticity, credibility, representativeness and meaning (Scott 1990). However, documents are seen as relevant to the concerns of the social researcher and are non-reactive, meaning the possibility of a reactive effect can be discounted as a limitation on the validity of data (Bryman 2012). Although, documents have

[1] SOPAC also known as The Pacific Islands Applied Geoscience Commission is an intergovernmental and regional organisation that conducts research on environmental issues as well as looking after water issues in the Pacific (Barnett and Campbell 2010).

been largely subjected to content analysis, discourse analysis has also been used in the interpretation of documents.

Discourse Analysis

Discourse analysis is one of many approaches in post-structuralist theory. Post-structuralist approaches are critical in nature and a huge deal is attributed to how scientific and scholarly knowledges are produced, organised and communicated in specific institutions (Wylie 2015). Much of the work on discourse analysis is associated with the work of Michel Foucault, which I draw on in this study.

I carried out a discourse analysis of the documents I collected from government ministries and relevant websites. Phillips and Hardy (2002) say it is through discourse that social reality is produced. As such, I wish to study the language used in these documents and also see what has been left out (Duncan and Duncan 1992). The use of language in these documents is important as they (re)produce the power and knowledge of those who produced the work. Institutions can therefore manipulate or emphasise a certain discourse based on their primarily 'scientific' understandings on which I also focus my discourse analysis. Wodak and Meyer (2002) defined critical discourse analysis as involving the analysis of structural relationships of dominance, discrimination, power and control through language. They also argue that discourse is historically produced and that dominant structures are legitimated by ideologies of powerful groups. Here, discourse analysis will inform this study through identifying the type of language used in the documents produced by government ministries and understanding the power relations represented in their work.

Discourse analysis builds upon textual analysis and is often referred to as deconstruction. Discourse analysis treats texts as mediated cultural products which are part of wider systems of knowledge which may set the limits for, or discipline, everyday life (Hannam 2002). Hence, deconstruction is interested on not only what is in a text but also what has been left out (Duncan and Duncan 1992). Some of the questions important for discourse analysis include 'What are the discourses presented in the text?', 'What is left out or missing from the text?', 'What are the power relations presented by the discourse?'. Discourse analysis has helped me uncover, or dare I say remind me, of certain discourses on

vulnerability, sustainability and adaptation in the context of climate change in Tonga as well as the Pacific. These discourses continue to be presented in the material on climate change with regards to Pacific countries and SIDS.

Interview and Focus Group Analysis

The method of interview analysis was also applied to the focus groups. I firstly transcribed each of the interviews and focus groups in Tongan exactly as they were said by participants before translating them to English. This helped quicken the process of analysis once the oral was turned into the written form and ensuring nothing is left out. After transcribing, I proceeded to printing my transcripts in preparation for a thorough analysis. I analysed the data through open coding to help reduce the data collected to more meaningful points and thus generate themes. Strauss and Corbin (1990) considers that open coding yields concepts which are then grouped and turned into categories. I used different coloured pens to highlight the relevant texts that are useful for the research. In reading the transcripts, I noted the major ideas presented in the text and went back to rethink about what the participants talked about to generate the key themes for this research. I also noted down any repeated concepts that participants talked about which also led to the creation of key themes. This is not to say that only some texts are important but that selecting the main ones narrowed down the data for analysis.

The drawback of this technique is the generalization of people's answers and that I may overlook some information during the analysis process. Bryman (2012) identified one of the problems of coding is the tendency to lose the context of what is said. However, this form of analysis enabled me to reduce the large amount of data into a smaller and more useful body of information for the writeup of this research. I reminded myself of the opinions and experiences of the participants and tried not to leave out the important ideas they mentioned. Despite the potential consequence of using codes to reduce the richness of the data, it was quite necessary for the creation of themes.

I was interested in comparing the viewpoints and experiences of participants in the rural and urban context. I then formed a list of the main ideas presented by participants in the two settings and compared them to find the similarities and

differences they offered. This was important in order to answer one of my research questions on 'What are the experiences of water scarcity of residents in the Nuku'alofa area (urban) versus the Hihifo District (rural) area of Tongatapu?'.

Textual Analysis

Textual analysis is a qualitative technique concerned with unpacking the cultural meanings inherent in the material (Hannam 2002). Utilizing text analysis follows a similar pattern to the interview and focus group analysis in terms of reducing the data through open coding. However, text analysis draws upon the researcher's own knowledge and beliefs as well as the symbolic meaning systems that they share with others. As such, this analysis technique supported my interviews and focus groups in analysing what material was offered on the topic. Due to the many publications on climate change, I only focused on the relevant ones and was cautious of the time required for such an analysis. Given that this technique required going through the material a line or sentence at a time, I was able to get a thorough understanding by attempting to think about why and what was meant by the text. This was how themes emerged after the coding process was carried out (Hannam 2002).

It was important for me to include a text analysis of materials such as government documents, reports and press releases on water and climate change with particular reference to Tonga and the Pacific. The majority of the selected texts were from MEIDECC in Tonga as well as from SPREP and SOPAC websites. These provided me with the data that were necessary to draw some of the themes on water and climate change. The SPREP and SOPAC websites offered a range of texts in the form of reports and press releases which were useful for this research. However, given the topic and scope of this study, I only selected the ones that were of clear relevance to the topic. The process was time consuming but was beneficial in informing me and in making sure that I, the researcher did not miss out on what the text is saying.

Recruitment of Participants

Upon the completion and acceptance of my ethics application by the Human Research Ethics Committee in the Faculty of Arts and Social Sciences, I was then

able to begin my search for potential participants. I was convinced that the snowballing technique was sure to gain research participants hence, initially I asked friends and family to assist me in identifying some people who would be interested to join. Bryman (2012) refers to the snowball sample as a small group of people that the researcher first makes contact with in order to contact others. It was then time for me to go to Tonga to carry out my data collection. My mother was of great help as she worked in local government where I was able to interview a few town officers. Given that town officers have their busy schedules, I was fortunate to interview some of them as they shared their experience not only for their respective households but also represented the villages they came from.

The data collection spanned over two months during which I was able to carry out the semi-structured interviews and focus groups. A total of twenty-five people was interviewed and two focus groups were conducted in order for me to fully grasp a variety of views on the research topic. In using the snowball technique, I also contacted people using my existing networks in Tonga to negotiate a suitable time for the semi-structured interviews. The focus groups were people mostly gathered by the town officer of ‘Ahau and district officer of Kolofo’ou which was more convenient given the time and cost associated with conducting the focus groups. The participants ranged from 19 to 69 years old and consisted of male and female participants. Refer to Table 3. This age group offered various experiences with water supply in times of drought and climatic change throughout the years. This was a random selection of participants in Hihifo and Nuku’alofa and I ensured that no two participants were interviewed in the semi-structured interviews and participated in the focus groups.

Table 3. Participants' Details

Nuku'alofa District				
Names	**Age**	**Occupation**	**Village**	**Date**
Taniela	53	Consultant	Halaleva	15/912016
Mona	62	Consultant	Kolomotu'a	26/07/2016
Ariana	39	Teacher	Ngele'ia	30/07/2016
Ana	32	Tourist Officer	Halaleva	3/08/2016
Naomi	65	Housekeeping	Kolomotu'a	16/08/2016
Otolono	58	Housekeeping	Kolomotu'a	16/08/2016
Ofa	-	Assistant Secretary	Fangaloto	16/08/2016
Lilu		Co-ordinator	Hala'ovave	18/08/2016
Tahirih	37	Co-ordinator	Kolofo'ou	30/08/2016
Sina			Halaleva	15/09/2016
Hihifo District				
Oleanita	35	Teacher	Ha'avakatolo	22/07/2016
Akositaine	46	Officer	Kolovai	
Ofa	56	Teacher	Kanokupolu	5/09/2016
Luisi	56	Town Officer	Kolovai	5/09/2016
Sekona	59	Teacher	Kanokupolu	6/09/2016
Asinate	63	Housekeeping	Kanokupolu	6/09/2016
Olivia	21	Student	Ha'avakatolo	9/09/2016
Edna	47	Housekeeping	Ha'avakatolo	9/09/2016
Suli	69	Retired	Ha'avakatolo	9/09/2016
Lesieli	40	Housekeeping/weaving	Ha'atafu	9/09/2016
Government Officials				
Ofa		Director of Meteorology		10/08/2016
Quddus		Deputy CEO/ Engineering Manager (Tonga Water Board)		17/08/2016
Amelia		Assistant Geologist		17/08/2016
Leveni		NEMO Director		17/08/2016
Lu'isa		Climate Change Director		18/08/2016
Focus Group Nuku'alofa				
Tilila	50	Housekeeping	Houmakelikao	26/07/2016
Hiva	19	Housekeeping	Houmakelikao	26/07/2016
Kivalu	62	Family caretaker	Houmakelikao	26/07/2016
Christopher	22	Student	Houmakelikao	26/07/2016
Focus Group Hihifo District				
Hingano	64	Retired	Ahau	26/07/2016
Sivilaise	60	Housekeeping	Ahau	26/07/2016

Source: (Author, 2017).

Participants' Consent

Prior to the beginning of each interview and focus group I made sure to inform the participants of their choice to use pseudonyms or their real names. All of the participants stated that using their own names in this thesis was fine. Although I was reluctant to use their own names to make sure that no harm would come to the participants, I also followed their instructions.

Challenges in Recruiting Participants and the Data Collection Process

There were many challenges with the recruitment of participants and data collection for this research. Some of the people asked to participate were willing to join but were busy with their own matters and could not make it. Others were quite reluctant to join, and perhaps put off by the idea of participating in a university study. Nevertheless, I managed to gain participants who were of great importance to this research. Their shared experiences allowed me to be able to write this thesis as well as reflect on my own experience with water issues in Tongatapu.

I acknowledge that recruiting participants from Hihifo was a challenge as it is far from my village. Due to the location of the Hihifo District, I had to get there on time for the interviews and the focus group which was difficult due to the cost and distance. However, I was able to find participants for the interviews and focus group again through the use of the snowball technique. The two focus groups consisted of locals from the village of Houmakelikao, Nuku'alofa and the other from 'Ahau Village in the Hihifo district. A number of participants for 'Ahau's focus group could not make it in time and only two members eventually participated. Despite the turnout number in this focus group, its advantages included being able to control the discussion while allowing them to discuss in detail their views and opinions. Hence, having a few group members can have its advantages in research (Longhurst 1996).

The Nuku'alofa group consisted of four members, two of them were in their youth and the other two were much older which gave me a range of views from different age groups. However, there was a time during the focus group where some of them did not contribute a lot to discussion. I had to convince them that there was no wrong or right answer in order for them to share their views. However, silence may mean someone else already said what they thought or they have said what they wanted to say for the time being (Bennett 2002).

Regarding the interviews with government officials, I was conscious of interrupting their work time as I interviewed them at their workplaces. However, detailed explanations from them on the topic were much appreciated as well as

some information I obtained from some of them for the discourse and text analysis.

Positionality and Reflexivity

My positionality as the researcher is important to note as the research is mainly based on my understanding and viewpoint. However, this does not mean I have perfect knowledge of the field. Rose (1997) argues that authors who have resolved issues on positionality, can have a misunderstanding that they possess perfect selfknowledge. Hence one of the reasons for conducting this research is to gain new knowledge on the topic.

Positionality is about how people view the world from different embodied locations. The partial situatedness of knowledge means, whether we are researchers or participants we are differently situated by our social, intellectual and spatial locations, by our intellectual history and by our lived experiences. These all shape our understandings of the world and the knowledge we produce. I noticed my positionality as a university student did put a hesitant face on some participants with some willing to share and others not. Reflexivity means the selfconscious, analytical scrutiny of one-self as a researcher. Reflexivity gets us to think about the consequences of our interactions with the researched (England 2015). Taking into account the time I have spent living outside of Tonga, this has not changed my worldview on the water issues in the Tongan society. I consider what I have experienced growing up in Tonga greatly informed my research regardless of the time spent living in New Zealand more recently.

I acknowledge that my ethnic identity as a Tongan has influenced my decision to study Tongatapu. Hence, I understand the viewpoints of the Tongan people as an insider as we share the same culture. However, because I am the researcher, I will also be considered an outsider as I question people about their experiences and therefore, seem distant to the interviewee. This might influence the participants' answers and their willingness to open up about their experiences. Reflecting on my research experience as a young Tongan female, I had to remind myself that some participants may not want to contribute a lot due to this particular factor. This was reflected in having a majority of female participants as they were much easier to interact with and shared more of their experiences.

Coffey (1999) emphasizes the importance for the researcher to be reflexive and be aware of herself when doing fieldwork as this influences her study. In saying so, being aware of the setting of which I conducted research is important to understand the participants as well as for myself to be aware that my viewpoint will largely influence the sort of answers participants will make. This is through the types of questions I asked and the participants' way of answering them.

Conclusion

In conclusion, I draw my research methods from a qualitative research approach to conduct data collection on people's experiences with water scarcity and water issues in the context of climate change. The use of semi-structured interviews and focus groups helped with understanding people's behaviours and experiences and their adaptation to water scarcity. Not only did these two methods provide rich information for data analysis, they provided a deeper insight into people's lives in dealing with water issues. Documents as sources of data have helped me answer the research questions and most importantly compare where government ministries viewpoints are coming from in comparison to those of the people. In using discourse analysis as the tool to deconstruct these documents, I am certain of the institutional and power discourses which is present challenges the local people's views. Interview and focus group analysis is essential after the interview process and involves deconstructing the transcripts into meaningful ideas and themes for the findings and discussion of the thesis. Through combining these methods, I obtained a better understanding of the research and was better prepared for analysis.

I have learned some important lessons from utilising these qualitative research methods with regards to the context of Tongatapu. The following chapter looks at the findings that seek to answer the research questions outlined in Chapter One as well as a discussion of those findings.

CHAPTER FIVE: FINDINGS

Introduction

Climate change is often discussed in scientific terms, with the use of models and statistics to determine possible climate change trends. We see on television and read materials on climate change and its impacts from an outside point of view and tend to forget that climate change is experienced on a daily basis. In the context of Tonga, vulnerability is a key feature of adaptation at both the local and national levels.

In this chapter, I first provide a brief background on the study communities' water supply and demand for the participants involved in this study. I then discuss the impacts of climate change on water resources in Tonga and the link between climate change and water scarcity in Tongatapu. I discuss the role of ENSO in influencing rainfall and drought patterns in Tonga and describe the latest El Niño event which took place in 2015. I then move on to explain the experiences of the participants in an urban and rural context as well as their ways of coping in times of water shortage. I also explain the challenges they face when adapting to water scarcity.

All of the issues presented above require some sort of response. Therefore, the discussion goes on to cover the various responses considered by participants as well as those included in government policies and climate change documents. I discuss the adaptation measures for domestic water supply and agriculture in Tonga as well as the sustainability of Tonga's water resources. Of central importance is the social construction of vulnerability in which I deconstruct the PACC project in Hihifo and the role of vulnerability in aid provision. Climate change knowledge is contested as language becomes problematic in understanding climate change. Moreover, further discussion on addressing vulnerability in Tonga is based on the policy and planning frameworks that are focused on climate change. I then examine who has the power of constructing knowledge and adaptation in the context of Tongatapu. Lastly, an evaluation of the usage of water meters is investigated with particular reference to Hihifo and some thoughts from Nuku'alofa are outlined.

Characteristics of the Study Communities

The water supply of the Nuku'alofa District is operated and supplied by the Tonga Water Board. All participants indicated they have access to rainwater and ground water as their water source except two from the Nuku'alofa district who only had ground water (tap water) for their consumption. Those two participants had access to groundwater without having their own cement tank at home. This places pressure on that one source of water and on the neighbours, when asking for water as soon as the taps stopped running. Apart from the cement tank, water can be collected in water barrels and other forms of water storage containers such as bins and buckets when harvesting rainwater. A number of participants specified it is the parents' responsibility to take care of, and manage, the water supply at home. This was in contrast with certain views that looking after the water supply at home is everyone's responsibility.

Hihifo's water supply is overseen by the Ministry of Health and each village has its own water committee and town officer that looks after the water supply. Almost all participants from Nuku'alofa and Hihifo mentioned that the lack of water supply is due to the misuse of water. There was not much difference in the water demand among the Nuku'alofa participants versus those from the Hihifo District. This depended on the number of people in a household. The villages of Kolovai, 'Ahau, Kanokupolu and Ha'atafu have their water supply distributed from Kolovai, with their water source coming from inland. The villages of Fo'ui and Ha'avakatolo each have their own water source. This separation of villages with their own water sources benefit villages who can operate their own water supply. However, the rest of the villages from Kolovai to Ha'atafu may experience more water related issues as they share the same water source.

Figures 10 and 11 shows considerable differences in household density among the participant's households in the Nuku'alofa area and Hihifo District. Household members amongst Nuku'alofa interviewees have a higher average household density of 8.1 whilst Hihifo has 7.1. On the other hand, Nuku'alofa focus groups had an average of 7.75 household density compared to 9.5 in Hihifo. The lower household density in Nuku'alofa could be a result of fewer members participating in the Hihifo group. This does not reflect a true representation of Nuku'alofa and

Hihifo household density because each participant has a different number of people in their respective households. Although the data shows the number of people per household, as there is no mention of the size of housing (number of bedrooms) it is not possible to judge the density of accommodation. However, Figures 10 and 11 are important as households with more members generally demand more water than those with fewer household members. For example, from the interviewees alone, sixty percent of participants from the Nuku'alofa District said that living in Nuku'alofa affected or increased their demand for water. This is compared to only forty percent in Hihifo who said water demand is affected when living in Hihifo which could be a result of fewer household chores than in the urban context.

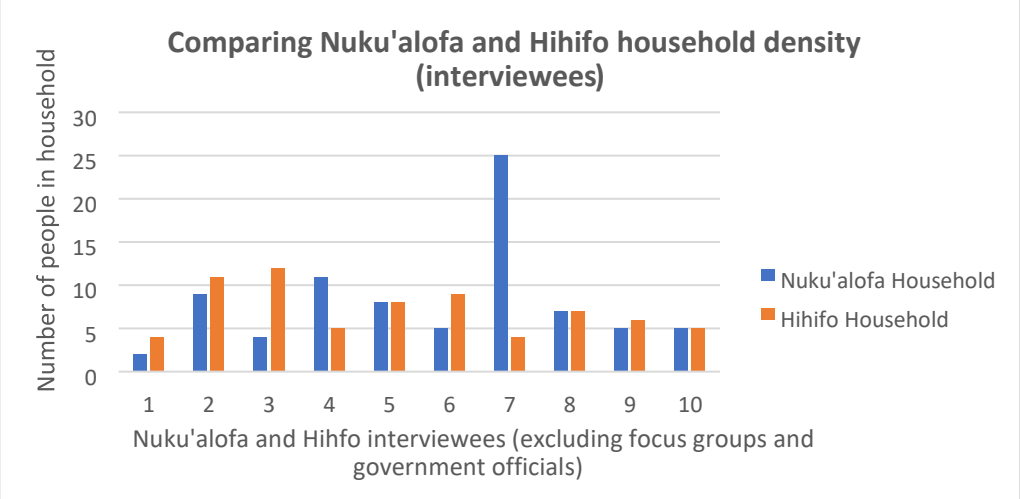


Figure 10. Comparison of household density among interviewees from Nuku'alofa and Hihifo District. (Source: Author).

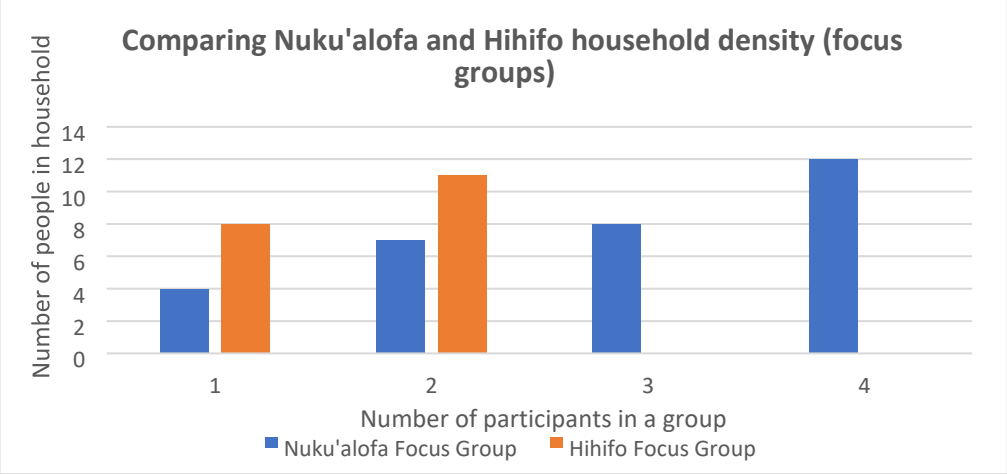


Figure 11. Comparison of household density among focus group members from Nuku'alofa and Hihifo District. (Source: Author).

Tongatapu's Water Resources: Climate Change Impacts

Climate change does not necessarily affect water resources in a direct manner but rather does so in an indirect way. Hence, impacts are largely a result of climate variability rather than changing climate means. I stress here the influential role of droughts on Tonga's water resources and extreme dry conditions that have occurred both with reference to participants' experiences as well as being recorded in documentary data. These climatic conditions impose some worst-case scenarios for Tonga's water resources in the context of climate change. Tonga's fresh water resources are highly dependent on the availability of rainfall. Here, a meteorological point of view is attained.

'Ofa Fa'anunu: the main drivers of rainfall here in Tonga are first, the South Pacific Convergence Zone where most of our rainfall is produced and then we have the El Niño Southern Oscillation which is a cycle that happens every four to seven years that controls a lot of the rainfall.

We are able to identify climate change through the recording of climatic data and the rainfall patterns that form over a period of time. Groundwater recharge is primarily dependent on rainfall, however only a small percentage goes into the water lens which results in the loss of most rainwater that does not go into the water supply.

Already, water is seen as a scarce resource in the islands of Tonga (Tu'iafitu 2012). Climate variability continues to put pressure on this limited supply especially that of groundwater. If this variability is increased by climate change, water insecurity is likely to become an increasingly important issue.

Drought and its impacts on Tongatapu's water resources

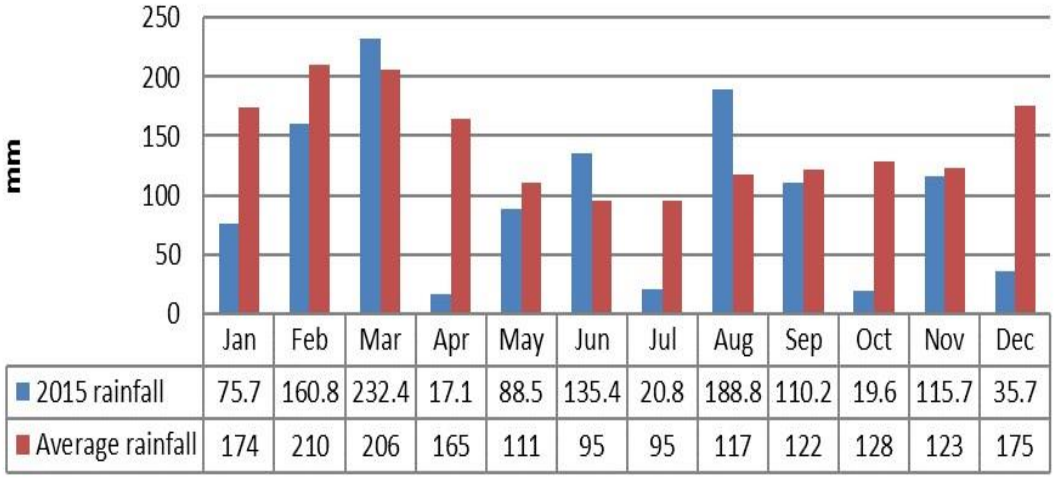
The occurrence of droughts in Tonga has been an indicator of water scarcity or lack of water supplies in households. Since the recording of climatic data in 1945, droughts have often been associated with the occurrence of the El Niño phase of ENSO. Droughts are also evident in the lack of rainfall especially over the dry season from May to October. These natural events have the most impact with regards to shortage of water in Tongatapu and even the outer islands (especially Ha'apai).

According to Tu'iafitu (2012), the number of droughts in Tonga has increased especially in the later years of 1975 to 2007 compared with 1945 to 1975. The duration of droughts on average is about 14 months and the spacing between droughts, is about seven years. However, in addition to these timeframes I also consider the shorter time span of droughts or what many would call the time of extreme sunny conditions. The primary impacts of these droughts on Tongatapu's water resources are the shortage of water supply and the water quality being affected. During droughts, the lack of rainfall means a lot of cement tanks are on the verge of becoming empty and groundwater recharge is slow resulting in saltwater intrusion having a high chance of occurring.

El Niño Southern Oscillation's impact on rainfall and drought in Tonga

Tonga's water supply is highly dependent on rainfall. Therefore, the supply of rainfall can be altered in the occurrence of ENSO. There is particular attention paid to the impact of ENSO on the rainfall pattern and in reference to Tongatapu where this study is based. Some of the weather condition that El Niño events bring to Tonga include cooler night temperatures from May to October and hotter day temperatures from November to April. There is also lack of rainfall and more than average chances of cyclones occurring (MEIDECC 2015b).

Figure 12 shows the monthly rainfall for Nuku'alofa in the year 2015. The El Niño event resulted in nine out of twelve months having below average rainfall. The lack of rainfall in these months especially in the months of January, April, July, October and December correlates with what participants experienced. Fa'anunu (2016) also states that there are two types of El Niño events in the Pacific, the Canonical El Niño occurring in the Eastern Pacific and the El Niño Modoki which happens in the Central Pacific. Fa'anunu (2016) reports that El Niño during the summer causes severe drought.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015 rainfall	75.7	160.8	232.4	17.1	88.5	135.4	20.8	188.8	110.2	19.6	115.7	35.7
Average rainfall	174	210	206	165	111	95	95	117	122	128	123	175

Figure 12. Monthly rainfall for Nuku'alofa during the 2015 El Niño event (Fa'anunu, 2016).

Figure 12 illustrates the dry weather taking place during El Niño recorded over the year. La Niña on the other hand (Figure 13) improves the water supply by having more rainfall.

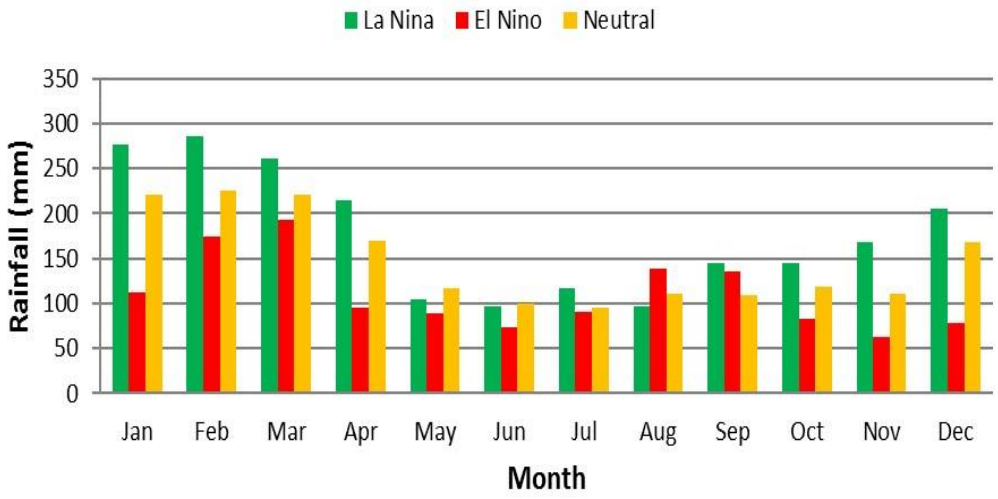


Figure 13. Average monthly rainfall during different ENSO phases in Nuku'alofa (Fa'anunu, 2016).

The years presented in Figure 14 are those where drought occurred in Tongatapu. The navy blue represents the El Niño Modoki showing that this type of El Niño is more frequent than the Canonical El Niño (yellow) and also more intense. The El Niño event that took place in 1982/1983 caused widespread

drought throughout Tonga (Tu'iafitu 2012). This specific period was in line with the occurrence of Tropical Cyclone Isaac in 1982.

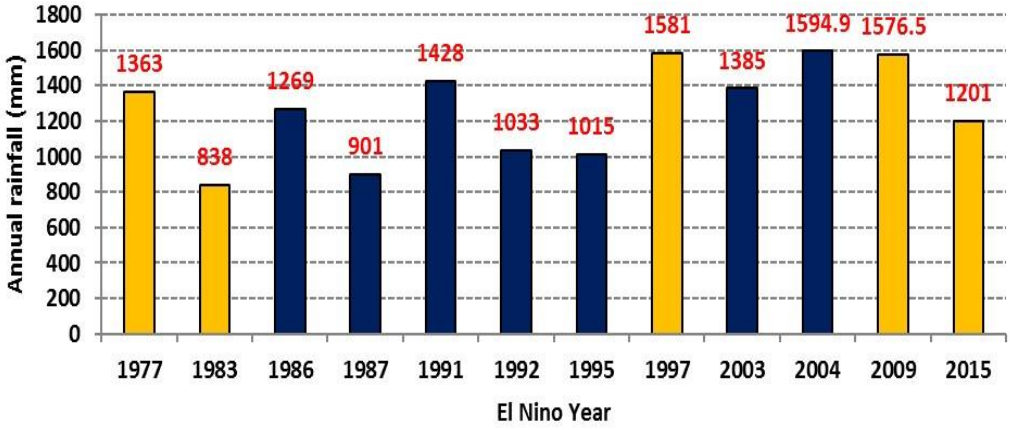


Figure 14. Drought years in Nuku'alofa and the classification of El Niño types (Fa'anunu, 2016).

Hence, these years of drought are similar and are evident in the discussion of some participants when they experienced water scarcity in the past.

Hingano: I remember from 1977 it was a sunny year… and the problem was clear, very clear due to the extreme sunny conditions. And up to recent years such as in 1982 that's when Tropical Cyclone Isaac occurred… in the 90's there was another extreme sunny period, maybe it's 93 or 94 from what I remember. It was heavily affected, the water supply, drinking water was based on the rain and we have some places where we could go and buy water. But the thing is, it was problematic, it was not clean.

It is clear that Hingano's experiences coincides with Figure 14 showing the years that Hingano mentioned were years when El Niño was present in the kingdom. Therefore, the occurrence of El Niño can be tied to the drought events affecting water quality and quantity in Tonga.

Linking Climate Change to Water Scarcity in Tongatapu

Over the long run, climate change will have an impact on Tongatapu's water resources. This will especially be linked to climate variability such as ENSO which is projected to occur frequently in the future (CSIRO *et al.* 2015). However, the likely relationship between climate change and ENSO is not yet confirmed despite the influential role ENSO plays on the water supply.

Once again, we need to acknowledge the difference between climate variability and climate change as current adaptation is largely in response to climate variability. This is especially true in the context of this study as most participants experienced and shared their adaptation strategies to water scarcity in the short term. Holloway (2005) advises that much academic and policy focus on the impact of droughts and floods is often reactive. Alternatively, adaptation to water scarcity in the context of climate change is viewed as a long-term problem. Drawing from Mukheibir (2007) adaptation to climate variability focuses on responding to short term shortages while climate change requires long term adaptation strategies to reduce vulnerability.

Climate Change Knowledge: Climate or Weather?

The majority of the participants shared their knowledge and understanding of climate change on a short-term time scale based on their day to day experiences of weather. Others discussed climate change with reference to seasonal changes throughout the year that are often overlapping onto other seasons. Participants considered the weather according to the seasonal changes over the years to the present. Most of the answers related to the differences in the pattern of the current weather and seasons. Edna of Ha'avakatolo said:

> When it is supposed to be warm (weather) it's cold. When it's time to be cold the warm season is still going. What I understand about climate change it's not like in the past, to say it's sunny time then it's sunny. No, it's raining (it's out of season?) yes.

The knowledge of climate change shared by the government officials depended on the various departments they were from. Hence, the representative from NEMO shared from a disaster management point of view and how climate change has the potential to worsen natural extreme events. Leveni 'Aho from NEMO stated:

> We are focusing more on the natural disasters, what I mean, extreme weather like now, we had rain but two months ago, we had 311mm rain in less than 24 hours. To me, that's extreme so it's related to climate change such as drought, it's longer.

From the Meteorological point of view, 'Ofa Fa'anunu indicated that climate change is:

> the change in the average climate in a particular place or country over a long period of time. For example, 30 years, 50 years, 100 years. In the work that I do, a climate record is equated to 30 years of climate data. So, when we compare climate in the past and climate at the present we look at the average weather or the climate over a long period of time.

Both Leveni and ‘Ofa have understandings of climate change that are based on their respective work experience and are scientific in nature. The record of climatic data underpins their knowledge of climate change and more importantly reflect the institutional background in which climate change is contested.

Christian Worldview and Biblical Reference

As a Christian country, the worldview that Tongans have will be reflected in their answers on what they understand about climate change. A few participants did not see climate change as a threat and expressed a strong belief that God is in control of nature.

Naomi: if God says no rain, there will be no rain. And if the Lord says for the rain to come, then it’s up to him with regards to water…

When asked if his garden can be made more drought proof, ‘Akositaine responded

‘Akositaine: if it rains then it rains and if it is sunny then pray a lot to keep it [crops] alive.

There is strong support of biblical references amongst participants on solving water issues. One participant referred to the Good Samaritan from the bible and the importance of helping the injured and not looking for a way out. With reference to solving water issues and problems with the water supply such as water connection to the main pipe, he said it is important to help others without debating who is responsible for looking after water. Another participant showed contentment with an assured mind that the Lord answers prayers, even when we complain of why it takes long for the rain to come. There is also a belief that praying goes hand in hand with work in order to achieve results, which is also biblical. Thus, if people only pray without making an effort they may not see the

result of an abundance water supply. Therefore, it is also important to take action in collecting water to conserve in times of drought.

Experiences of Water Scarcity in the Context of Drought and Climate Change

Water as Basic Need

Water is a significant part of life and, not surprisingly, all participants stated that water is important because it is one of humans' basic needs. Water use is not only limited to domestic use but also livestock and crop production.

Climate Change: Natural or Human Induced Activities?

More than half the participants interviewed indicated that climate change was a natural phenomenon and related climate change to the changes in weather and certain seasons overlapping into other seasons. Although, this was the case, a few people explained that climate change was a result of human activities taking effect on the earth's atmosphere. The majority of participants only focused on explaining its impacts and did not really consider the human activities that contributed to climate change. Although Tonga has a relatively small per capita rate of greenhouse gas emissions compared to more developed countries, it was identified that the transport sector contributed the most to Tonga's greenhouse gas emission.

Lu'isa Tu'i'afitu: Transport is the sector that has the most emission in Tonga compared to power generation, joined by forestry and agriculture sector and waste.

It is interesting to see that transport takes the top spot of greenhouse gas emissions given the small size of Tonga and the increasing number of vehicles imported into the country.

Environment and Economic Implications

Climate variability and drought do pose some threats on the environment and economic capacity in Tonga. Agricultural produce increases in price in times of droughts as less crops are available in the market from a not so successful yield. The majority of the participants indicated that the price increase of crops is not

beneficial for themselves. ‘Asinate from Hihifo shared that fish are found dead on the shore because there is too much sun. The agriculture and fisheries sectors are two of the most basic livelihoods for the majority of Tongans. Drinking water is affected by droughts and people have to resort to buying water from the shop. Such an alternative is costly, especially at the household level when family members pay for their drinking water. Climate change could further exacerbate the impacts mentioned before which disadvantage people’s livelihoods and damage the environment.

Coping with water scarcity in droughts

The most common response on coping with water scarcity is using water wisely. In addition to that was buying bottled water that was easily refilled from the shop. All participants turned to purchasing bottled water as an alternative source during water shortages in their respective households when there was drought.

The most common way of coping with water scarcity in Hihifo was fixing the water pumping machine. A few said water scarcity was not a concern as they have not really experienced having extreme water scarcity. Taniela and a number of participants said that rationing was important when coping with water scarcity. When this method of conserving water was no longer applicable in times of need then they had to resort to various alternatives including buying water from the shop and also getting water from a nearby well as mentioned by ‘Otolono.

A few participants interviewed stated that water shortage is associated with problems of water quality.

Tahirih: the issue of water scarcity for me would be the water quality not good enough for people to drink because of the flood, you know, it’s the flood zone… so instead of water scarcity in that sense, there’s abundance of water but it’s polluted.

Tahirih’s response shows that water scarcity can be experienced in the context of floods without limiting the idea to that of droughts. Floods becomes a challenge for adaptation especially with groundwater becoming polluted from excessive floodwaters entering the groundwater supply.

Barnett and Campbell (2010) affirm that the capacity of people to absorb or cope with the external threat and/or the potentiality to recover from it are properties that are internal to their social (including political economic) -ecological systems. Most often, what is considered vulnerable are seen as passive and the threat that is climate change is the active agent. Participants see themselves as vulnerable perceiving climate change as the external threat to their society. The vulnerability complex outlined by Watts and Bohle (1993) considers that if the threat does not exist, then no matter what the conditions of the community, it cannot be vulnerable to that phenomenon.

Based on the perceived vulnerability of water supply in Tongatapu, the church has been a fundamental site for locating communal water tanks. These water tanks are a common practice throughout Tonga and are not limited to a specific place from which people obtain water. Thus, the church is one of the key sites where the village water supply is located, particularly for cement tanks. This additional source of water supply is an advantage for the people as Lilu has mentioned.

Lilu: with the cement tank, once it's empty we get water from the church, from the cement tank at the church.

Lesieli: For here, there was a project that brought two water tanks… and they were positioned in the two church halls… So it's the Free Wesleyan Church and the Church of Tonga because that's the only churches here that most families are in.

Lilu, a participant from Nuku'alofa and Lesieli from Ha'atafu in Hihifo illustrate that the church is an important location for installing the village water supply irrespective of what districts they are from. Given that the church is an important part of many Tongan lives, it is necessary to target the church for future instalment of water tanks. This is especially the case in Ha'atafu, the furthest village in the Hihifo District which Lesieli experiences drought and water scarcity about two to three times a year. This is more than what other participants said, as they experience shortages usually about once a year and is in conflict with the climate data in Figure 12.

Challenges faced when adapting to water scarcity

Participants have coped with the lack of water supplies in times of drought and extreme events despite the limited availability of the resource. At the household level, the main barrier to adapting to water scarcity has an economic element to it. The inability, and at most times not paying attention, to pay the water bill on time results in the water supply being disconnected from the main water supplier. In addition, buying water from the shop inflicts the burden of further costs on the drinking water. This approach to the burden of buying bottled water seems contradictory to the fact that most participants turned to shop-bought bottled water in times of water scarcities.

About three participants indicated that sharing with the neighbours may cause the shortage of water in their household. The sharing of rainwater in some households is common because it is usually not tied to water expenses like groundwater. A number of participants voiced their experiences of having no access to a cement tank which results in asking the neighbours for rainwater or buying from the shop. However, this does not usually mean that the availability of water reaches a critical stage of having no water at all.

Other problems when people adapt to water scarcity are health related. It is common that rainwater in cement tanks contains mosquito larva. This causes serious health effects such as dengue fever and other diseases. The other problem is that pigs often damage the water pipes and it is often unnoticed. People need to be aware of any leakages that occur in their household and if so, install the proper fencing to decrease the likelihood of events like this from happening in the future.

Crop production

The majority of the participants said they have a garden in the bush for their family's food consumption. Those who did not have a garden in the bush lacked access to land. A few participants do have land, but are not utilising it and instead lease the land for others to use.

Tahirih: we are currently leasing that land, we get some from the produce umm… once a year. I think what we're planting there is too small a scale to say it's providing for us for the whole year because a lot of our root crops are from the market.

Some voiced their experience over the increasing price of agricultural produce at the market in times of drought as the quality of crops also declines. An interesting finding in this study was that four participants who were interviewed from Hihifo both had a garden at home and in the bush for their food consumption. Two out of the ten only have a food garden at home and four said they do not have a garden at home but only in the bush.

Another challenge for crop production was taking water from the participant's home to the bush in order to water the garden. The process involves the cost of water as well as petrol for delivering the water. Such a process is not favoured but essential, especially in El Niño times when rainfall is lacking.

Water Scarcity: A Natural or Technical Problem?

All participants from Hihifo indicated that their shortage of water at the household level is mostly attributed to technical failures of the water pumping machine. This is reflected in the running of the water supply at certain times of the day in order not to stress the water pumping machines. Luisi Fifita of Kolovai said:

> the problem is not having a water machine to make it four, so two can run in the morning and then stop and the other two run in the afternoon to rotate, because if it runs continuously, it won't reach last the three years.

Luisi's concern is about the limited number of water pumps in the Hihifo District. In particular, water pumps have a short time that they can run when there are only a few to operate for the villages of Kolovai, 'Ahau, Kanokupolu and Ha'atafu. This is increased by water scarcity as a derivative of droughts and extreme sunny conditions with particular reductions in rainwater stored in the cement tanks. All participants said that drought was the most important contributing factor to water scarcity. Although, water became short in times of extreme sunshine, there is still access to water considering the household demand and number of people in the household. It was only during extreme drought periods (refer to Figure 14) that

participants hardly had access or no access to water supply at all. It was either the rainwater tank was empty or the groundwater stopped because of lack of maintenance on the water supply. Other issues included the disconnection of water by the Tonga Water Board or by the water committees in the rural villages due to unpaid bills.

One of the technical failures that participants mentioned was the effect of leakages on the water pipes underground and loss of rainwater from cracks in the cement tanks.

> ‘Ofa Masila: I notice when there is a drought, the cement tank runs out of water and there are problems such as the cement tank cracks.

What I found was that participants from Nuku’alofa emphasised that water scarcity was caused by environmental processes accompanied by not paying the bill on time with little reference to technical problems. In contrast, the participants from Hihifo referred to technical problems as the main concern, followed by droughts. They did not really have a problem with their water bill as they only paid a fixed amount which was relatively small in comparison to the Nuku’alofa area’s usage of water meters.

Health concerns

PIC’s are often confronted with non-communicable diseases such as diabetes and high blood pressure from high consumption of imported foods. However, climate change impacts diseases that are climate and or water sensitive. Rokho *et al.* (2015) stated that since 2012, there have been over 40 large infectious disease outbreaks in the Pacific region. A few of the most popular ones include; dengue, chikungunya and the Zika Virus which were also present in Tonga.

Although none of the participants experienced any water related issues to their health, they nonetheless expressed their concern over the possible consequences of water scarcity affecting health. They raised their ideas on cleanliness and the importance of better sanitation so as not to exacerbate certain diseases. One person said that diseases are often said to be vector borne but they are rather water borne. However, the list of disease outbreaks mentioned above are vector borne. Vector-borne diseases are infectious diseases spread by insects, typically

mosquitoes that carry bacteria and viruses (PSR 2013). Increasing temperature and rainfall are favourable conditions for mosquitos' survival. Hence, climate change increases the likelihood of vector-borne diseases. There are other insects such as ticks and fleas that are vectors, but I focus on mosquitoes as they are the primary cause of disease outbreaks in Tonga. On the other hand, water-borne diseases refer to diseases such as infectious diarrhoea resulting from poor hygiene and the spread of contaminated food and drinking water (PSR 2013). Again, the increase in temperatures, rainfall and flooding worsened by climate change may increase water-borne diseases.

Hence, health is important to consider in this study as the lack of water poses some serious health scenarios that can be worsened by climate variability and change. An outbreak of dengue fever can be tied to the El Niño and drought event in 2003 during which a majority of patients were from the Western District in Tongatapu. Tu'iafitu (2012) recorded that the dengue outbreak in the years 2004 and 2007 were primarily from Hihifo. This is especially due to the ideal mosquito breeding grounds in Hihifo where seawater is mixed with groundwater (brackish water).

Responding to Climate Change and Water Scarcity in Tongatapu

The response to climate change in the water sector is dependent on decision making regardless if it is the local or national level. However, although local and national levels both consider adaptation, adaptation is largely experienced at the local level. Yet, top down and bottom up approaches both aim to enhance people's adaptive capacity. The enhancement of people's adaptive capacity at various levels of decision making is considered by Thornton *et al.* (2014) as the most significant element of reducing vulnerability.

Climate Change Policy and JNAP (Top down approach)

The issue of climate change is one of the top priorities in government agendas and more work has been done to incorporate adaptation into the national level policy in order to achieve a resilient Tonga. The Tonga Climate Change Policy is an indicator of progress already made by the Government of Tonga in the move towards a resilient future by 2035. This was a continuation of Tonga's first

climate change policy set in 2006. The policy aims to reach sustainable outcomes on various agendas. Hence, sustainability is a critical component of achieving a resilient Tonga. Yet, resilience would need to incorporate some form of adaptation in order to be achieved. Nevertheless, the Tonga Climate Change Policy has stated that addressing climate change based on adaptation or mitigation is fragmented in nature. Hence, they have taken a more holistic approach to build resilience where people are able to respond proactively to the effects of climate change.

The development of the Water Resources Bill and the National Water Policy in Tonga is a move forward at the national level to mainstream climate change and disaster risk into the various planning and policy frameworks. The drafting of the Water Resources Bill in 2016 served the purpose of providing the management, protection and conservation of water resources in the kingdom (Tonga Government 2016). The endorsement of the National Water Policy in 2011 also took into account the effects of climate change and disaster risk on water (Tu'iafitu 2012).

The PACC Project

According to the PACC report on Tonga, Hihifo was selected as the project site due to the problems they had with their water supply. It was also adapted from the government of Tonga's policy on infrastructure development including improving the livelihoods of rural and outer island communities. A future projection for the Hihifo District implies that climate change and sea level rise mean Hihifo will be affected by drought and saltwater intrusion. Indeed, one of the problems was the sharing of water resources between the village and the four resorts in the Hihifo District. It was either the village or the resorts were supplied with water, which caused problems of insufficient water supply for one or the other.

Community Consultation

It is recognised that working with the community is a critical part of water related adaptation to climate change. The sharing of knowledge and awareness of climate change adds to the adaptive capacity of the community as well as reducing their so-called vulnerability against climate change and water resources. It is with great

importance that people are acknowledged in what things are to be done to adapt to climate change and get to discuss the implementation of certain projects dealing with climate change. MEIDECC has been the focal point in consulting the communities on climate change especially for the PACC project in Hihifo villages. Lu'isa Tu'i'afitu stated that MEIDECC has carried out many consultations on climate change with the public especially when the PACC Project was initiated. It was important for Lu'isa and her team that consultation continues to be an ongoing process that will build awareness of climate change and its impacts so that people are knowledgeable and become prepared. However, she was also hesitant due to the people's reaction to repeating the same thing when they came to the villages to do consultation.

Increased Awareness

One of the most common responses to dealing with water scarcity and climate change impacts was to increase awareness of the issue. This was not limited to the opinions of government officials but also the participants from Nuku'alofa and Hihifo. One method used by MEIDECC was conducting consultations with the communities of Hihifo especially with regards to the PACC project. These consultations triggered awareness of climate change and its potential impact on Hihifo's water supply. Although it was intended to encourage and increase people's knowledge of the phenomena it was not always an easy task.

The PACC report especially favours community education and awareness to reduce water wastage and leakage, and promoting water conservation (SPREP and Government of Tonga). However, this report indicates that only with the support and participation of the community, especially women and children, will small islands be able to reduce wastage and move towards sustainable development of their freshwater resources. I tend to be critical of such a target and question why women and children are singled out as unsustainable in the use of water resources. Is it because they are at home most of the time or use more water?

Local Knowledge and Agricultural Adaptation

It is acknowledged that participants from the Hihifo District demonstrated a range of methods to increase the resilience of their gardens and withstand the impacts of drought and climate change. This is reflected in the setting they are living in, as the rural areas have access to land and farming is part of their livelihood. Participants from Nuku'alofa very much depend on the market for their food consumption and thus did not display a lot of knowledge on improving their gardens in times of drought. This is because only two out of ten participants interviewed in Nuku'alofa have access to land in the rural areas and are utilising it for their food consumption. Two participants have access to land in the rural areas but are not using it for their own reasons. Two participants have no garden at home or in the bush for their consumption and all members of the Nuku'alofa focus group had no food crops at all for their own households' consumption.

Box 1 shows methods used are an indication of the local knowledge that is still prevalent in the lives of farmers and gardeners. Nakashima *et al.* (2012) have highlighted the importance of traditional knowledge in small island societies but this is increasingly eroding because of reduced intergenerational knowledge transmission.

Box 1. Crop adaptation measures to withstand drought and climate change.

- Bring coconut husks and turning them upside down on the garden.
- Soak the coconut husks to keep the soil moist if it is a vegetable garden.
- Cut the banana tree and trunks, take out the inside and use what is left to tie it to the vegetable to keep it moist for a longer time duration.
- Leave the weeds there to slow down the sun's strength.
- Collect the crop's skin and place them on the base of the plant. These will rot and are good in keeping the soil moist and help the crop grow well.
- Collect the dry coconut leaves and place on top of the weed to provide shade.
- Sweep the rubbish (leaves) to the base of the plant to maintain soil moisture.

Source: Hihifo Focus Group participants, Hingano and Sivilaise, 2016.

Adaptation to Water Scarcity and Climate Change

There were a variety of adaptation measures that were identified in the PACC report on Hihifo's water supply and could be applicable to the Nuku'alofa area and Tonga in general.

Out of all the options in Box 2, participants have emphasised the first point of expanding their water storage in order to store more water for times of drought. It can be seen that people are only concerned with drought that may occur in the near future such as the coming summer season instead of long term climate change. In practice, this is appropriate as people will take action if the problem is going to happen in the short term compared to long term climate change. However, this may be an advantage because when people are able to adapt to short term droughts, they are better prepared to face the increased long duration of droughts that are projected to occur in the future. Adaptation to water shortages in the summer months and extremely dry conditions prepare people to cope and endure the consequences that prolonged droughts bring.

Box 2. Adaptation options on water resources applicable to small island scales

- ❖ Expansion of rainwater collection schemes
- ❖ Groundwater protection measures (example, from chemical pollution)
- ❖ Land use planning and water reserves
- ❖ Coastal management and protection
- ❖ Desalination
- ❖ Importation of water

Source: After PACC report on Tonga's In-Country Consultations. (SPREP and Government of Tonga).

The Sustainability of Tongatapu's Water Supply

The one thing that various discussions and materials relating to climate change and variability in this study often result in, is concern about sustainability of water as a resource. It was important that adaptation in the water sector incorporate the idea of sustainability for the use of future generations. Hence, sustainability and adaptation are not separate entities but rather are interrelated in the face of climate change.

Sustainable Water Practice at the Household Level

Paling and Winter (2011) have indicated that household sustainability has received far less attention in the developing world. Most often, this is because households in the developing world tend to consume less than those of the industrialised countries. I argue that this approach to sustainability in the household need not be limited to developed countries and rather, people in SIDS and PICs could do their part to manage water in their own households irrespective of the development state of these countries.

Given the scope of this study which focuses on the household level, the home or the participant's household is the starting point for adapting to water shortages. It is important to look at the home as a site of effective adaptation as each household member could do their part on reducing water wastage. Thus, through implementing sustainable practices in the home, there is hope that such practices become a lifestyle instilled in the households of Tonga.

It is important to know that although households are often the target in initiating water management practices. Paling and Winter (2011) consider that household practices are complex and changes may not be easily accomplished. I support this idea as some members of the household may care about rationing water while others may not. Therefore, changes may only happen if all members of the household agree to the same values, that is the sustainable use of water. This is especially a concern for the person paying the water bill as unsustainable water practices in the home would possibly become a burden. This responsibility is often taken by the person in the household who is in paid employment.

Lilu: For managing the cement tank that would be my dad and my brother… but when it comes to the paying of the bills and stuff it's me, and also refilling of the water bottle, again it's me.

Lilu's response is actually common among participant's answers and even to the majority of Tongan households in terms of paying the water bill, the person working usually ensures this.

The most common practice that participants mentioned about water was the importance of using water wisely and rationing in times of drought. Some

participants talked about the need to look after children since they tend to play with water when unsupervised.

Constructing Vulnerability

Climate change assessments of adaptation and mitigation measures are often profoundly centred around the idea of vulnerability. It is with great significance that it is difficult to discuss climate change without incorporating the vulnerability of a particular community, place or country. The ways the term has been presented in the Pacific context and SIDS have their advantages and drawbacks when debating adaptation and climate change matters.

I seek to discover discourses around vulnerability in the context of climate change especially with regards to the Pacific context, Tonga included. I argue that the use of such a discourse leads to a negative perception of specific places especially with reference to climate change. I also highlight that vulnerability discourses tend to be used as a reason for help from overseas countries. However, this may not necessarily be useful as certain places have different needs and are differently exposed to climate change impacts. Moreover, I show how the term is utilised in institutions and how it differs from the local, calling for an integrated effort in combating vulnerability.

The following presents works by the Tongan government as well as reports from relevant organisations such as SPREP and SOPAC on how the term vulnerability has been utilised to inform decision making and policy. In doing so, I question whether vulnerability is the problem or whether vulnerability is produced by people and institutions to create an image of a specific place. I also show that emphasising the discourse of vulnerability does not necessarily address climate change adaptation, which often takes the focus away from adaptation measures to climate change. In addition, I indicate that vulnerability is not only a product discussed in institutional works but is rather a label that a specific population give themselves.

The Image of Vulnerability. Victims or Not?

It is not surprising that a specific population or place may be targeted as *vulnerable* when reading materials on climate change. What becomes of this

increasingly used discourse is the acceptance of this label by those who are seen as vulnerable themselves. The Pacific Region and SIDS have always been represented as part of the most vulnerable places in the world for various reasons. The most obvious ones include their low socio-economic profile as well as their island characteristics that expose them to natural hazards. Climate change and climatic variability are no different and questions about who is vulnerable are always at the forefront of climatic debates. The PACC report on Tonga's consultations indicated that Tonga is vulnerable to extreme climate events and coral bleaching from high ocean surface temperatures.

The focus group conducted in 'Ahau village of Hihifo, Tongatapu involved participants experiences with the Pacific Adaptation to Climate Change project. When asked about why they thought the project was conducted in Hihifo and not other areas? Hingano observed

> we are vulnerable. Hihifo is one of the vulnerable places in everything. It starts from Fo'ui and onwards, it's called the Lausi'i, sea from there, water from there, we are lucky to be alive…

Sivilaise was also convinced that they were selected because of their vulnerability.

Sivilaise: I believe they saw that we are vulnerable. We are closer to, where natural hazards occur and we are looked after because of problems like that…

Hingano and Sivilaise see themselves as well as their village as vulnerable to natural events. The labelling of vulnerability to a person or place is indeed problematic. It tends to portray an image of weakness and dependency that I argue is not necessarily the case at least in the context of Tongatapu. However, taking into consideration the physical characteristics of Hihifo and the Vulnerability and Adaptation assessment studies in the area, it was the so-called vulnerability of Hihifo that prompted the PACC project to be implemented there.

In the context of climate change, Pacific Island Countries are constantly reminded of their vulnerability in the face of climate change. I argue that this does not do a lot to combat the impacts of climate change and should not divert the focus away from reducing greenhouse gas emissions. Although, Pacific

Island Countries including Tonga, have the characteristics of being vulnerable, this often takes the spotlight whilst the important thing is addressing greenhouse emissions and actually adopting adaptation measures. Barnett (2001) supports this idea that PICs would be unwise to ignore issues of vulnerability and adaptation and should not serve to downgrade the importance of mitigation. Most often, the image of vulnerability is constructed by the West as a form of power by deeming the 'other' as vulnerable (Barnett and Campbell 2010).

There is consistent (re) production of discourses of vulnerability of PICs in the context of climate change. PICs are seen as the victims of this phenomenon and continual focus on their smallness, isolation and fragmented characteristics is commonplace. Barnett and Campbell (2010) highlight the danger of using such discourses as they may enable practices that entail powerful people doing adaptation to island communities, rather than enabling those countries to do adaptation for themselves. It is with this thinking that I focus in this study on the provision of aid through the PACC project which I argue did not necessarily result in continued adaptation. This is not to say that the project did not do its part in enhancing people's adaptive capacity but rather it did not address the problem of long term adaptation.

The Role of Vulnerability in Aid Provision

The PACC project in Hihifo, Tongatapu was very much centred on the vulnerability of the district. According to the in-country consultations that took place in Tonga on PACC, the District Officer of Hihifo mentioned that saltwater intrusion is common due to the narrowness of the land in western Tongatapu as well as receiving less rainfall than other parts of Tongatapu. It is characteristics like these that trigger the selection of certain places to receive aid as in the example of the PACC project. I highlight the important role of vulnerability in encouraging the inflow of aid to a certain place. There are also certain views shared by participants on donations and help especially from overseas to be implemented because of *vulnerability.*

Adger *et al.* (2003) say the vulnerability or security of individuals and of societies is determined not only by the likely responses of the resources on which individuals depend but by the availability of resources and crucially by the

entitlements of individuals and groups to call on these resources. Yet, a community may have the resources but are actually too focused on their vulnerable image that triggers external help rather than taking action themselves. The availability and improved access to water resources in the Hihifo District by the PACC project assures the continuous supply of ground water but should not conclude or limit people's adaptive capacity to water scarcity. Therefore, rain water should not be ignored but used to complement ground water when adapting to water shortages.

Although, the PACC project was primarily focused on upgrading the water supply, the Hihifo villages were also in need of coastal protection. The immediate impact of sea level rise was a concern among the villagers which is unquestionable as saltwater intrusion is evident in their groundwater supply. One person interviewed discussed her village's experience with fundraising for their village's foreshore without the government's help.

'Asinate: there was a small work done by the village fundraising to ask for help from the military and they said they can't help because there is a big landfill on our foreshore. And some people come and it's like they are teasing our little foreshore… because it's low but that's the foreshore that sustains it. But it's the community's fundraising, there was no help from the government.

'Asinate saw that her village's problem was not because of their vulnerability as a village located near the sea, rather the problem was the government not helping. I contend that vulnerability does not always depend on the exposure of a certain place to climate change impacts but rather, on what help they get. 'Asinate specified that the PACC project helped them with their water problems which is an indication of an increase in adaptive capacity. However, regardless of what determines vulnerability, aid provision is a sign that the recipient of such help is deemed to be vulnerable to environmental extremes. 'Asinate goes on to share the comparison of help done in Hahake to Hihifo in building the foreshore.

'Asinate: For Hahake it is good that the government helped build a foreshore, for us it's poor, it's our effort and some people come and tease it because it's not a big rock. Thankful it's still withstanding the sea and not coming inland.

‘Asinate’s comparison of the Hahake (Eastern) District with the Hihifo District hints that they consider themselves to be vulnerable to sea level rise. It is such comparisons that often lead to debates and conflicts especially with regards to aid provision for certain places.

Complexities of the PACC Water Project/ What Should be Done

It is not surprising that there can be opposing views on how a project should be implemented. Some participants expressed their concern over the distribution of the water tanks that were provided for some households.

Edna: they should have seen those households that are crowded. What’s bad about adding another cement tank up to two because they are crowded?

It is clear that some people were not pleased with the operation of the PACC project in Hihifo. A few said that water storage could have been increased so everyone can get a lot of water in reserve. This was highlighted by some of the government officials on working with the community. They stated that working with the community is often a challenge. Not everyone agrees with what is being presented to them and this creates conflicts among the locals and with the project team. There is an expectation that these things will occur because they are dealing with not one individual but many. Consulting the community about projects on climate change and passing on the message on what is to be done poses a challenge to the government and the project team. However, conflicts may be reduced if the government and its team target those who have not been consulted so as not to repeat the same processes with the same people. Lu’isa from the Department of Climate Change shared that communities have told them that they have already been over consulted and they don’t need more consultation.

Coming from an institutional point of view, projects including PACC have proven to help people adapt to future climate change impacts on their water supply. However, Quddus Fielea of the Tonga Water Board stressed the importance of working with the village water committees in enabling them to operate and sustain the water supply in the rural areas. This was seen as the problem with the PACC project, the struggle to maintain the system.

Quddus: it needs maybe five years or ten years to make sure it sustains and the people can operate it, coming and bringing the infrastructure for the people, they don't have the resources and skills so it's a big problem.

It was clear from Quddus's response that a long-term plan and timeframe for not only the PACC project but also other projects are needed to ensure the sustainability of the water supply. It is essential that the water committees in the rural villages have the capacity to operate such a task.

Addressing Vulnerability in Tonga's Climate Change Policy and Planning

Tonga's 2010-2015 JNAP aimed to reduce vulnerability and risk and to enhance resilience to the impacts of climate change and natural hazards. This particular national action plan was very beneficial in the creation of Tonga's Climate Change Policy in targeting a resilient Tonga with an outlook to 2035. Although, a number of vulnerable sectors and solutions were offered, little reference was made to what the local communities deemed as their priorities to be addressed. However, the vulnerability and adaptation assessments focused on the sectors that need attention including those on which people based their livelihood. This is also in line with Tonga's Second National Communication on Climate Change Report which seems to be structured along the lines of vulnerable sectors and end solutions to address the vulnerability of each sector. However, it runs the risk of misunderstanding in the public which are the targeted audience of these institutional works. This is in the form of listing the solutions which may lead to further dependence on the national level for assistance in adaptation. Moreover, the Tonga Climate Change Policy has six main objectives that are expected to be achieved by 2035. They are listed in Box 3.

Box 3. Tonga Climate Policy main objectives.

- Mainstreaming for a Resilient Tonga *(To fully mainstream the goal of a Resilient Tonga into government legislation, policies and planning at all levels)*
- Research, monitoring and management of data and information *(To implement a coordinated approach to the collection, monitoring management, analysis, and use of all relevant data and information; and to develop a coordinated, multi-sectoral approach to research for building a Resilient Tonga)*
- Resilience-building response capability *(To develop the capability for resilience-building responses throughout government, the private sector, and civil society)*
- Resilience-building actions *(To implement actions that are designed to build a Resilient Tonga by 2035 at national, island, and community level)*
- Finance *(To secure and mobilise the required finances and resources to build a Resilient Tonga by 2035)*
- Regional and international cooperation *(To develop and maintain strong regional and international partnerships and to contribute fully to all relevant negotiations aimed at the required transformation to a resilient and sustainable future)*

Source: Tonga Climate Change Policy. (Government of Tonga, 2016)

We can see from Box 3 that resilience is the key focus of this policy. What I am focusing on is vulnerability and how this is presented and addressed in these institutional works. Tonga's climate change policy has progressed into a resilience framework instead of (over)emphasising the vulnerability of people and the islands. What is particularly positive about this policy is that it is actually addressing the underlying causes of vulnerability, such as finance and access to resources, institutional improvement in managing and collecting data and sustainability. However, since this policy took on a holistic approach, it is problematic to figure out how these objectives can be achieved.

Local Interpretation of Climate Change in Tonga

Indeed, one of the problems with interpreting climate change when communicating in Tongan is the lack of differentiation between climate change and the change in weather. As mentioned earlier climate change is more of a longterm change whereas weather is more of a short-term phenomenon. Hence, language becomes a barrier to understanding and interpreting climate change in Tonga. Although some participants described climate change as a human induced

activity affecting the atmosphere, these answers did not outnumber the responses that climate change is a natural thing and that nature or God is in control. Accordingly, we cannot do something about it but be prepared for what's about to come. Moreover, people understand climate change as a disaster that will occur.

'Asinate shares her understanding of climate change with reference to natural disasters.

> the people are poor, but what to do, the people are already prepared in the training that's done to prepare for when a disaster comes.

At this point, 'Asinate displays her sympathy with the people in her village for a disaster that is coming. It is though climate change is a fear that they should overcome. The point is, climate change should not be communicated as something that should be feared as people tend to go back to labelling themselves as vulnerable and this may even cause panic. On the contrary, such reactions may encourage the local people to boost their adaptive capacity by thinking of ways to adapt when climate change impacts are likely to occur.

Others share their understanding of climate change in relation to the environment.

Taniela: to me climate change is the manifestation of what man [sic] is doing to the environment, and changing and altering uh... things that were established by nature and when those things are being upset or have changed, the consequences are climate change.

Ariana also emphasised that climate change is an anthropogenic environmental problem. When asked, what she understands about climate change she replies;

> it is just the changes to natural things caused by humans and their activities on the land and the environment.

Taniela and Ariana's interpretations reflect a partial knowledge of climate change. Yet, other participants also displayed a similar understanding of what they understood about climate change. They only looked at a certain aspect of climate change without considering the other features of what climate change entails. This may be a result of what worldview they possess or that they are not fully certain about what climate change is and its causes. I emphasise that participants tend to interpret climate change by its impacts rather than the causes.

This shows that climate change awareness and training in Tonga is perhaps too focused on the impacts climate change may bring rather than the causes. Nevertheless, the focus may be on the impacts as Tonga contributes very little to its causes.

How Much Do People Know About Climate Change?

What do people actually know about climate change? A few participants were uncertain about what climate change is and the majority heard about climate change with reference to the changing in seasons and daily weather. This is problematic when people perceive climate change as a short-term process because that is what they know. What people do not realise is that climate change is long term and most of what is to happen is predicted in climate projections. About 90 percent of the participants indicated that climate change is happening, yet they are only aware of the changes happening in the short term or from natural variability. Given that Tongatapu and, in reality, all of Tonga can run into some unintended consequences from the impacts of climate change, they may be slow to recognize these effects due to the lack of knowledge on the issue. However, climate change awareness is on the rise and Tongan schools are looking at incorporating studies on climate change to start awareness from a young age (Tu'iafitu 2012).

Power, Knowledge and Adapting to Climate Change

It is widely recognised that adaptation is affiliated with the local and community level. Hence, knowledge on climate change adaptation is often dealt with at the grass roots level because this is where adaptation actions often take place. Increasingly, adaptation knowledge presented in the climate change literature with reference to the Pacific region is attributed to the works done by institutions. The institutions dealing with climate change have the knowledge and power of representing climate change in the context of Pacific Islands. In this case, the government of Tonga and its responsible ministries have the power of communicating climate change to the public. Most often, the local level does not have a say in the creation of such information. I argue that this only reflects a partial knowledge of what actually is present on the matter of climate change. Adaptation has always been at the local level, however, it is also important that it

is incorporated in institutional works in incorporating local knowledge with scientific knowledge.

Barnett (2001) implies that a 'no regrets' approach to decision making about climate change adaptation in the face of uncertainty prevails. Hence, certain strategies are favoured because they yield benefits whether or not the climate change impacts occur. Barnett and Campbell (2010) say we need to situate climate change in the broader context of social, cultural, economic and environmental changes in PICs in order to make efforts to enhance adaptive capacity consistent with local needs and values. Communities value things differently and these must be taken into account if adaptation is to be effective, efficient, legitimate and equitable. Adaptation would be difficult in communities that do not see themselves at risk from climate change. This may be the most challenging thing to overcome in order to facilitate adaptation in the Pacific.

For generations, Tongans have adapted to climate variabilities such as ENSO and short-term droughts but these actions are often overlooked and the focus is shifted to climate change adaptation. Essentially, climate change adaptation is like introducing a new agenda to decision making when it has long been advocated at the local level. As evident from this study, water adaptation has traditionally been done at the local level. The increasing knowledge in contemporary times such as using desalination plants is just an addition to what has been implemented in Tonga especially such as new ways of adaptation in the use of technology to increase people's adaptive capacity. Increasingly, climate change has started to be recognised as one of Tonga's first priorities (MEIDECC 2015a). This is particularly apparent in Tonga, with the creation of the first Parliamentary Standing Committee in the Pacific focusing on climate change, the environment and disasters. The knowledge that the government and its ministries have can be trickled down to the local level through town officers and district officers who are the messengers of climate change knowledge to the people.

Most participants in Nuku'alofa did not know of any projects in the area regarding water and climate change. Only a few mentioned this but referred to the past as the timeframe for when such projects occurred. I assume that this is because they were not aware of any water projects or on the other hand, they were just not interested in such help on the water supply. I also discovered that the

PACC project in Hihifo was a replication of the Hahake project which was seen to be successful (MEIDECC 2015a). Although, I was not aware of the Hahake project as the initial project similar to that in Hihifo, it is positive to see that those who are considered 'vulnerable' to water issues are enhancing their adaptive capacity. Yet, I sense that people may be over dependent on external help considering their limited resources to increase their own adaptive capacity.

Impact of Culture on Water Resources in Tonga

The Tongan way of living and morals instilled in the Tongan people involve the sharing of resources especially within family and even among neighbours. This way of giving is normal in Tongan society but could become a barrier to sustaining water resources, especially at the household level. I argue that sharing of water resources is not a problem unless it puts stress on others and it becomes inconvenient. By others I refer to neighbours and those without a cement tank. Some participants shared their concern about stealing water as well as poverty as the underlying factors for the dependence of people on other's water supply.

> Taniela that's part of our culture is to share…what we have, including water… What will happen if we don't have enough water to go around. It will break down the community system, people will fight for water aye, ask to share and at the social level if we don't share you'll become an enemy or you become a stranger in your own community because you break the customs or the cultural sensitivities of um… relating to your neighbours…

Despite the physical characteristics of Tongatapu as exposed to climate change, people are quite resilient in the social and cultural context. The strong community ties and kinship relations means sharing of resources is the norm. Leveni explained that extended families help provide support structures in times of need. Yet, in contemporary times, there are people who are becoming accustomed to the individualistic lifestyle brought about by western influences. Thus, the value of sharing is no longer necessary. However, despite the implications of an individualistic lifestyle, extended families looking out for each other still dominate in contemporary Tongan society. Hence, resilience is increased but may become problematic if it encourages too much reliance on others.

Improving Crop Adaptation/ Incorporating Local Knowledge

One of the most basic if not fundamental elements of adaptation to climate change and water scarcity is the obligation to improve crop and agricultural adaptation. Adger *et al.* (2003) emphasized that adaptation may reduce dependence on vulnerable systems such as diversifying food production away from a limited number of drought-prone crops. However, diversifying food production away from a limited number of drought-prone crops, may not be applicable in the context of Tonga. All participants claimed that cassava and yam are two of the best crops to grow in times of drought. Therefore, there may not be many choices in terms of diversifying crops in times of drought due to the limited crop varieties available. However, interestingly enough, one person mentioned that taro is good to grow in times of drought and another participant mentioned that kumara is also good although it is described by the other participants as weak and usually unable to withstand the strength of the sun. In the case of other participants, taro is not considered a strong crop in droughts which indicates that knowledge about crops vary among people.

It is noted that not putting in an effort to look after the garden for food consumption is a barrier to achieving successful adaptation. When asked how does he cope with the problems associated with crops, Suli responds

> Here in Tonga, the soil is very good and healthy and there's plenty of rain, there's hardly a time when we have to soak the crops. The problem is if you are lazy to look after the cassava and yam.

Suli's response represents an important part of looking at improving adaptation in the agriculture sector. Whether it is growing a food garden at the home or at the bush, effort is needed to maintain the crops regardless of the weather conditions, which may be a barrier to sustaining agricultural produce.

Kivalu from the Nuku'alofa focus group talked about the knowledge of how the soil is used in order to produce good crops. He talks about an island called Fotuha'a and the good yam produce they have which is due to how the soil is maintained.

> the length of the yam in Ha'apai and all the yams are unlike Fotuha'a. So, it depends on how they use their soil. What they do, they don't carelessly burn it. Remember when we burn the soil, living things in the soil will die. So, it's very important we take care of the natural state of the soil for the drought.

Looking after soil enables crops to obtain nutrients from the natural state of the soil. This is often not the case in Tongatapu where chemicals are sprayed to increase growth and for getting rid of pests. Hence, it is not necessarily considered sustainable as such practices can infiltrate into the groundwater supply. Tu'iafitu (2012) encourages maintenance of traditional farming of mixed crops and rotation of cultivation among different ground and tree crop species or varieties. This is especially beneficial in times of natural hazards because ground crops are known to be more vulnerable to droughts while tree crops are more vulnerable to cyclones (Tu'iafitu 2012).

Tongans have adapted their agricultural practices to changes in the weather and climate through various traditional techniques. The use of the Tongan calendar was especially influential in yam production and processes. Hence, yam is considered the most noble crop, and is associated with the king and nobles including the forecast of weather through yam production (Pole). Lefale (2010) also, highlighted the importance of documenting traditional ecological knowledge of weather and climate in Polynesian communities. Such documenting captures the valuable but fading knowledge that has sustained the communities not only in Polynesia but throughout the Pacific. Therefore, traditional ecological knowledge can be merged with scientific knowledge to inform the wider public of a variety of adaptation options to participate in.

Although climate data on rainfall and weather forecasts help to predict times for harvesting rainwater, traditional forecasting techniques have been utilised by the local people for a long time. Nakashima *et al.* (2012) say that traditional forecasting techniques have been used in small island societies in the face of such changes. The inhabitants in small island societies mostly used observation techniques to capture the forthcoming weather conditions such as observing types of clouds and their colour, looking at the sea and the waves as well as the wind and its direction. It is knowledge like this that has been helping people adapt to

changes in nature. I stress the importance of maintaining these knowledges in combination with the science and the records of climatic data. If the science and the traditional knowledge are treated separately we are then ignorant of the knowledge that has maintained the societies in the past.

Sustainable Crop Practices at the Home

Sustainable practices should not be limited to water only but also crops as they provide sustenance for the household and family. I came across some interesting practices in Nuku'alofa that are worth noting.

> Monalisa: the pig pen, it's a European pig pen and it goes to the septic which produces gas and we use it for cooking. And when it's washed, that stuff (manure) turns into soil and that is collected and used for the garden.

I discovered that urban areas can also adopt such practices such as those used by Monalisa who resides in the Nuku'alofa District. Monalisa's crop practice was far from my expectation considering the context of the urban areas where people tend to be less attentive to crops as those from the rural areas. It comes to show that gardening in the urban areas and homes can be a way of sustaining food crops in the future at least in the urban context (Thaman 1995). It is knowledge like this that has the potential to increase better adaptation for not only in the urban but also the rural villages in Tongatapu and outwards to the outer islands.

The Usage of Meters: A Good Thing?

There tends to be conflicting views about the introduction of meters in the Hihifo District. Although the intention is to help water conservation and to have income to operate the water supply, it does not necessarily benefit the customer especially in rural areas. Hihifo generally has lower cash incomes.

> Suli: I preached for us to have meters to be fair because there are households that have many members but only pay $6 pa'anga. So, if it is on average, their usage of water they use more water than us... but the meter cannot be installed because it is expensive.

Suli is emphasising the importance of fairness and equity not only among Hihifo's households but in the larger picture to have the same method of meter

payment used in Nuku'alofa. I suggest that this issue may only be achieved if Hihifo has the same water method and payment as Nuku'alofa since meters also encourage water conservation. However, the downside is that Nuku'alofa is where major water related activities are and their 24-hour water accessibility is not the same as in Hihifo. Therefore, it is not surprising for Hihifo residents to reject the usage of meters, however, some households in Hihifo have started using the meter since the PACC project was completed.

There have been controversial debates on the usage of meters and some people see this method as helpful such as 'Ofa Fifita of Kanokupolu.

> what I noticed, I make sure that the water is not wasted because it must be paid for.

The problem with adopting water meters in Hihifo is the cost involved. Suli's position on using the water meter is a good idea but the financial costs of adopting this measure create a barrier to effectively ensure that fairness is achieved. Pricing and water markets can result in reducing access to water by marginalised communities. This creates an induced social water scarcity and associated social stress, normally for the poor (Mukheibir 2010). This is in line with 'Ofa Masila's experience of other people who are less fortunate and unable to access water.

> there are families that are poor … They don't have a water source, some cannot afford to have a water tank … the rubbish bin that is chained on the roadside by the sea they bring it and wash it and bring it to our area to fill up water and take it. I feel sympathy with some families that are in a situation like that.

'Ofa Masila's answer indicated that those in poverty or rather worse off, are the ones who will be adversely affected the most. Hence, using the water meter may not be the best option in water adaptation as not everyone has the resource capacity to adapt to water scarcity.

Water Scarcity: A Political Problem?

For the most part, the problem with water scarcity is attributed to the accessibility to water resources to people. Mukheibir (2010) points out that poor access to

water is often confused with physical water scarcity and that water security is not always determined by scarcity. It is understood that the causes of scarcity are largely institutional and political. Mukheibir (2010) again, emphasises that scarcity occurs due to three key elements. They include depletion and degradation of the resource, population growth and unequal distribution or access.

In the case of the project in Hihifo, all of the participants mentioned that the project was evenly distributed. They based their answers on the assessment and survey that first took place in identifying the most vulnerable households in need of water tanks. In terms of water accessibility this has been addressed in the PACC project with some households having access to water for 24 hours a day while others continue to have a problematic water supply.

‘Akositaine: it’s a problem, the main problem in Hihifo is water. But it means the water pumping machine… It’s a problem for a long time in Hihifo, up to today it’s still a problem. We still cannot have water running 24 hours for a long time.

Water scarcity is as much a political problem as a result of climate variability and change. However, because adaptation is vested in the local level, people may not always have the resources to cope, therefore resulting in government intervention. People can only manage their water supply when there is strong institutional backup of resources to enhance their adaptive capacity to water shortage. When asked, who should be responsible for managing the water supply, all participants referenced town officers, district officers, the government through the Tonga Water Board as the first things that come to mind. Others indicated that it’s everyone’s responsibility to look after the water supply and ensure the safety of their water supply.

Sina: it’s everybody’s business, everyone has to be very wise and to be careful with the water they use and how they are using it.

The participants from Nuku’alofa focused more on TWB as the main supplier of water in Nuku’alofa urban areas and Hihifo participants referred to their water committees as well as town and district officers. The Ministry of Health was also mentioned as the key agency in ensuring the safety of the water supplies in each household.

Conclusion

Climate change is expected to cause stress on Tongatapu's water resources through the projected frequency of El Niño and drought in the future. Therefore, water and agriculture will be adversely affected as drier than normal weather continues to impact Tonga. There is a need to address the confusion between what is meant by weather and climate, as language is a barrier to understanding and interpreting what climate change is. There are considerable differences between what urban and rural residents experience in terms of water scarcity due to the different needs and resources available for water usage. The construction of vulnerability continues to be the focus of climate change literature especially on PICs and SIDS.

There are lessons learnt from the PACC project in that it needs to have a longer timeframe for sustaining and operating the water supply in Hihifo. After all, a community would be better able to adapt to climate change and water scarcity when they increase their adaptive capacity. A part of increasing this adaptive capacity is having a project with a longer timeframe for people to learn how to manage and operate the water supply in the long run. There are various adaptation options however, they may not always necessarily benefit the consumer such as in the case with the water meter. Therefore, the poor are most likely to face inequitable access to water, which raises questions about whether water scarcity is more of a political problem than a result of climate change.

CHAPTER SIX: CONCLUSION

In the introductory chapter of this thesis, I outlined the research questions and overall question guiding this study. *How could people in Tonga adapt to water scarcity in the context of drought and climate change?* In order to answer that question, the following points offer response to the research questions about the context of Tonga and people's experiences with water scarcity. Discourses around vulnerability and sustainability challenge adaptation in the water sector in Tonga especially at the household level. I have also highlighted the significance of power and knowledge on climate change in Tonga and the need to maintain local knowledge in the water and agriculture sector.

In response to the first research question; w*hat are the likely impacts of drought and climate change on the water resources in Tonga?,* these processes are linked to the water supply. Tongatapu's water resources are affected through the occurrence of ENSO and natural hazards such as tropical cyclones and droughts. Hence, it is not climate change itself but more so, climate variability. In that case, the lack of rainfall in the case of droughts contributes to the shortage of water but not necessarily to the extreme of having no water at all. Hence, participants indicated that water shortage also implies an impact on the water quality because of saltwater intrusion from sea level rise. Upon conducting the interviews, I discovered that climate change and droughts are not the only causes of water scarcity but there are other threats where human activities have already caused the shortage of water.

After interviewing participants from Nuku'alofa and Hihifo I was able to answer my second research question; w*hat are the experiences of water scarcity of residents in the Nuku'alofa (urban area) versus the Hihifo District (rural area) of Tongatapu?* There are two parts to this question, the first relates to: *how have people coped with water scarcity in times of drought?* Secondly, *what challenges have they faced when adapting to water scarcity?* A range of coping strategies were shared by participants with the most common answer of buying water from the shop as an alternative water source in times of water scarcity. This was not limited to the Nuku'alofa area as participants from Hihifo also turned to water consumption from the shop as a way of coping, which was not limited to droughts

but also flooding. The second coping strategy was more of addressing the technical failures of the water-pumping machine in the context of Hihifo. I also found that local knowledge of crop adaptation in times of droughts proved useful when water is needed at such a time. Alternatively, coping and adaptation to water scarcity indicated some challenges in the life stories of the participants. The foremost challenge was the lack of storage capacity for conserving water, followed by the need to pay the water bill on time. Hence, there is always an economic element to achieving successful adaptation. A range of challenges were identified which included health concerns about vector borne diseases and sharing with neighbours which puts pressure on the remaining water supply at the household level.

The use of discourse analysis has been fundamental in answering the third research question; *does aid improve or discourage people's capacity to adapt to water scarcity?* Before embarking on the answers to this question, I first sought to identify the construction of vulnerability in the context of climate change in PICs and SIDS. It was essential to find out the role of vulnerability in the provision of aid (referring to the PACC project) which helps to improve people's adaptive capacity in the face of climate change in the water sector. I found that participants had a different perception from government officials in the sense that aid helps the people (participants view) whereas, government officials tend to be critical of the project stating that it needs to be long term for better adaptation.

Given that this study is focused on adaptation, I sought to find answers for the fourth research question; *what actions have been taken and what can be done with regards to water scarcity?* I have outlined in Chapter 5 the initiation of the PACC project in Hihifo of upgrading and supplying infrastructure in addition to the conservation methods in the various households of each participant. In terms of top down approaches, the Tongan Government has implemented the Tonga Climate Change Policy and JNAP as two of the leading documents to guide adaptation in the Kingdom and to achieve a resilient Tonga. An important aspect of adaptation options was the introduction of water meters in the Hihifo District, which targeted water conservation.

Accordingly, how can sustainability be derived from these adaptation measures leads me to the last research question; h*ow do the adaptation measures in Tonga ensure the sustainability of the water supply?* The use of meters has its advantage of conserving water; however, at the same time it can marginalise the poor. People who are worse off may find it difficult to build their adaptive capacity given the financial constraints water meters can pose. Therefore, to achieve a sustainable water supply, poor people may have to forgo using the meter in order to save money for themselves.

Overall, the people of Tonga should consider the adaptation options outlined in Chapters 2 and 5. I understand that in order to achieve better adaptation in the water sector, a strong financial foundation is needed to reach that goal. However, I emphasise that people can practice adaptation at the household level by ensuring that water is used wisely. I also understand that using the meter will ensure that water is better conserved and encourage villages to perhaps consider using their water in a sustainable manner. Hence, it is not only a change in climate but also a change in attitude and lifestyle that could help withstand difficulties in times of drought and climate change.

Implications and Further Research

This research presents some challenges and the need for further research is pertinent in Tongatapu's water sector. I stress that further research on climate change and the water sector needs to ensure the sustainability of this limited resource. Despite the continual framing and labelling of PICS and SIDS as vulnerable, we need to shift the focus from vulnerability to having a more adaptive kind of thinking. Vulnerability is still the main discourse facing Pacific Islands at present concerning climate change. This labelling of PICs and SIDS does not necessarily reduce vulnerability unless adaptation action takes place.

There is a need for climate change awareness in the context of Tonga, especially when language could become a barrier to fully understanding exactly what climate change is about. In communicating climate change to the public, it is important to differentiate the meaning behind *changing weather* and *climate change* because they are both referred to using the same words *'feliuliuaki 'o e*

'ea'. With this misunderstanding in mind, people are only partially aware of what is to come in the future, as their mind-sets are largely focused only in the present.

I have a strong sense that culture does not do justice when dealing with water scarcity. In the Tongan context, sharing is a value instilled in the Tongan culture, yet, when droughts occur, sharing may turn into obligation for some households to assist others. It is not to say, that sharing water resources is bad but water supplies can become short and it should not become a burden. As I have learnt, vulnerability in the water sector is not solely based on the physical characteristics of climate variability affecting the water supply. On the contrary, political and economic barriers trigger vulnerability especially in relation to water meters. Consequently, accessing water needs to be dealt with at the national level, as it is as much a political issue as it is an environmental one.

In most cases, sustainability at the household level is often referenced to the developed world. I argue that this thinking should not be limited to the industrialised countries, yet it can be applied to the households in the developing world. I also see adaptation in other sectors should be studied carefully as climate change affects all areas of life whether it is economic, social, cultural or physical, climate change is a complex phenomenon. This study hopes to add to the existing knowledge on water adaptation in Tonga to consider long term visions and goals in relation to climate change. Adaptation is not new in the Tongan context, rather its whether it is an ongoing matter, more so because water is life!

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APPENDICES

Appendix One – Information Sheet

Semi-structured interview- Nuku'alofa (urban)

UNIVERSITY OF WAIKATO

FACULTY OF ARTS AND SOCIAL SCIENCES

Adaptation to water scarcity in the context of climate change in Tongatapu.

I am a geography graduate student at the University of Waikato. As part of my Master's thesis I am carrying out research on climate change and water scarcity in Tongatapu. The aim of this research is to explore how people could adapt to water scarcity in the context of droughts and climate change. I am interested in finding what ways have people coped with water shortages, whether you think climate change is linked to water scarcity, your experiences with drought and water scarcity and responsibility for managing water. Any views and opinions on ways to address water issues and what have been done or could be done when there is water scarcity is very much appreciated.

Interviews

For this research, I intend to conduct 10 interviews from the Nuku'alofa area (urban). The interviews are approximately half an hour to an hour depending on the participants needs. The participant is also welcome to bring up ideas about my research if necessary.

I would like to invite you to participate in an interview and I would also like to audio record the interview so that I have an accurate description of your opinions and comments.

What are your rights as participants?

If you choose to participate in my research, you have the right to:

- Refuse to answer any particular question
- Withdraw from the interview up to a month after the interview
- Decline to be audio recorded and request that recorder be turned off at any time.
- Request that any material be erased
- Ask any questions about the research at any time during your participation

Confidentiality

The research will take all possible steps to ensure your confidentiality. However, this cannot be absolutely guaranteed as you may be identifiable even if a pseudonym is used.

I will ensure that all interviews remain confidential. Only I will have access to the transcripts and any electronic information. All of the transcripts will be locked away in a cabinet at home or school.

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email fass-ethics@waikato.ac.nz, postal address, Faculty of Arts and Social Sciences, Te Kura Kete Aronui, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

The results

The results of the research will be used as part of my Master's thesis. Four copies of my thesis will be produced of which one of them will be accessed online. I may also use these results in presentations and/or journal publications.

What Next?

If you would like to take part in this research, I will contact you in the next week to organise a time to meet. If you have any questions, please feel free to contact me or my supervisor.

Jacqueline Fa'anunu

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Appendix Two – Information Sheet

Focus Group - Nuku'alofa (urban)

UNIVERSITY OF WAIKATO

FACULTY OF ARTS AND SOCIAL SCIENCES

Adaptation to water scarcity in the context of climate change in Tongatapu.

I am a geography graduate student at the University of Waikato. As part of my Master's thesis I am carrying out research on climate change and water scarcity in Tongatapu. The aim of this research is to explore how people could adapt to water issues in the context of droughts and climate change. I am interested in finding what ways have people coped with water shortages, whether you think climate change is linked to water scarcity, your experiences with drought and water scarcity and responsibility for managing water. Any views and opinions on ways to address water issues and what have been done or could be done when there is water scarcity is very much appreciated.

Focus Group

For this research, I intend to conduct 1 focus group from the Nuku'alofa area (urban). The focus group will run for approximately an hour depending on the participants needs. The participant is also welcome to bring up ideas about my research if necessary.

I would like to invite you to participate in the focus group. I will audio record the focus group session so that I have an accurate description of your opinions and comments.

What are your rights as participants?

If you choose to participate in my research, you have the right to:

- Refuse to answer any particular question
- Withdraw from the interview up to a month after the interview
- Request that any material be erased
- Ask any questions about the research at any time during your participation

Confidentiality

The research will take all possible steps to ensure your confidentiality. However, this cannot be absolutely guaranteed as you may be identifiable even if a pseudonym is used. I will ask members of the focus groups to observe the confidentiality of the group discussions but I cannot ensure this. Only I will have access to the transcripts and any electronic information. All of the transcripts will be locked away in a cabinet at home or school.

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email fass-ethics@waikato.ac.nz, postal address, Faculty of Arts and Social Sciences, Te Kura Kete Aronui, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

The results

The results of the research will be used as part of my Master's thesis. Four copies of my thesis will be produced of which one of them will be accessed online. I may also use these results in presentations and/or journal publications.

What Next?

If you would like to take part in this research, I will contact you in the next week to organise a time to meet. If you have any questions, please feel free to contact me or my supervisor.

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Appendix Three – Information Sheet

Semi-structured Interview - Hihifo District (rural)

UNIVERSITY OF WAIKATO

FACULTY OF ARTS AND SOCIAL SCIENCES

Adaptation to water scarcity in the context of climate change in Tongatapu.

I am a geography graduate student at the University of Waikato. As part of my Master's thesis I am carrying out research on climate change and water scarcity in Tongatapu. The aim of this research is to explore how people could adapt to water issues in the context of droughts and climate change. I am interested in finding what ways have people coped with water shortages, whether you think climate change is linked to water scarcity, your experiences with drought and water scarcity and responsibility for managing water. Any views and opinions on ways to address water issues and what have been done or could be done when there is water scarcity is very much appreciated. Your opinions on the PACC Programme in Hihifo villages is also important for this study.

Interviews

For this research, I intend to conduct 10 interviews from the Hihifo District (rural). The interviews are approximately half an hour to an hour depending on the participants needs. The participant is also welcome to bring up ideas about my research if necessary.

I would like to invite you to participate in an interview and I would also like to audio record the interviews so that I have an accurate description of your opinions and comments.

What are your rights as participants?

If you choose to participate in my research, you have the right to:

- Refuse to answer any particular question
- Withdraw from the interview up to a month after the interview
- Decline to be audio recorded and request that recorder be turned off at any time.

• Request that any material be erased
• Ask any questions about the research at any time during your participation

Confidentiality

The research will take all possible steps to ensure your confidentiality. However, this cannot be absolutely guaranteed as you may be identifiable even if a pseudonym is used. I will ensure that all interviews will be kept confidential. Only I will have access to the transcripts and any electronic information. All of the transcripts will be locked away in a cabinet at home or school.

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email fass-ethics@waikato.ac.nz, postal address, Faculty of Arts and Social Sciences, Te Kura Kete Aronui, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

The results

The results of the research will be used as part of my Master's thesis. Four copies of my thesis will be produced of which one of them will be accessed online. I may also use these results in presentations and/or journal publications.

What Next?

If you would like to take part in this research, I will contact you in the next week to organise a time to meet. If you have any questions, please feel free to contact me or my supervisor.

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Appendix Four – Information Sheet

Focus Group - Hihifo District (rural)

UNIVERSITY OF WAIKATO

FACULTY OF ARTS AND SOCIAL SCIENCES

Adaptation to water scarcity in the context of climate change in Tongatapu.

I am a geography graduate student at the University of Waikato. As part of my Master's thesis I am carrying out research on climate change and water scarcity in Tongatapu. The aim of this research is to explore how people could adapt to water issues in the context of droughts and climate change. I am interested in finding what ways have people coped with water shortages, whether you think climate change is linked to water scarcity, your experiences with drought and water scarcity and responsibility for managing water. Any views and opinions on ways to address water issues and what have been done or could be done when there is water scarcity is very much appreciated. Your opinions on the PACC Programme in Hihifo villages is also important for this study.

Focus Group

For this research, I intend to conduct 1 focus group from the Hihifo District (rural). The focus group will run for approximately an hour depending on the participants needs. The participant is also welcome to bring up ideas about my research if necessary.

I would like to invite you to participate in the focus group. I will audio record the focus group session so that I have an accurate description of your opinions and comments.

What are your rights as participants?

If you choose to participate in my research, you have the right to:

- Refuse to answer any particular question
- Withdraw from the interview up to a month after the interview
- Request that any material be erased

• Ask any questions about the research at any time during your participation

Confidentiality

The research will take all possible steps to ensure your confidentiality. However, this cannot be absolutely guaranteed as you may be identifiable even if a pseudonym is used. I will ask members of the focus groups to observe the confidentiality of the group discussions but I cannot ensure this. Only I will have access to the transcripts and any electronic information. All of the transcripts will be locked away in a cabinet at home or school.

This research project has been approved by the Human Research Ethics Committee of the Faculty of Arts and Social Sciences. Any questions about the ethical conduct of this research may be sent to the Secretary of the Committee, email fass-ethics@waikato.ac.nz, postal address, Faculty of Arts and Social Sciences, Te Kura Kete Aronui, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

The results

The results of the research will be used as part of my Master's thesis. Four copies of my thesis will be produced of which one of them will be accessed online. I may also use these results in presentations and/or journal publications.

What Next?

If you would like to take part in this research, I will contact you in the next week to organise a time to meet. If you have any questions, please feel free to contact me or my supervisor.

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Appendix Five – Consent form – Individual Interviews

RESEARCH CONSENT FORM – Interviews

Description of project: This research aims to explore how people can adapt to water issues in times of droughts and climate change. I am interested in exploring the phenomenon of climate change and how people cope and adapt with water scarcity in the context of climate change. Also, exploring people's experiences of water scarcity and problems they face with their water supply.

I have read the information sheet and understand that

- I can refuse to answer any question, terminate the interview and can withdraw from the research up to a month after the actual interview.
- All information will remain confidential
- My identity will remain anonymous and be protected by a pseudonym unless I state otherwise. I accept that I may be identifiable in the research, even if a pseudonym is used to protect my identity.
- All information collected will remain in a secure cabinet or on a computer that is only accessible through password.
- Information will be used for a Master's thesis, presentations, journal articles.

I consent to our conversation being audio recorded YES/NO (please circle)

I (your name) …… agree to participate in this research and acknowledge receipt of a copy of this consent form and the research project information sheet.

I understand that while the researcher will do her best to protect my identity it nevertheless cannot be totally guaranteed. I accept that I

may be identifiable in the research, even if a pseudonym is used to protect my identity.

I have discussed my representation in the research with the researcher and

- o I would like my identity to be protected by the use of a pseudonym o I would like to be identified by name (please select one)

_____ (to be signed and dated by the participant)

_____ (to be signed and dated by the interviewer)

Select your choice and sign if you agree to these terms and conditions.

- o I would like my interview to be archived
- o I am happy for the interview to be available to the general public/restricted to researchers/preserved for the use of my family members only. I consent to my interview being lodged in an audio archive for research purposes _____(please sign if you agree to this).

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Appendix Six - Consent Form- Focus Groups

RESEARCH CONSENT FORM- Focus Groups

Description of project: This research aims to explore how people can adapt to water issues in times of droughts and climate change. I am interested in exploring the phenomenon of climate change and how people cope and adapt with water scarcity in the context of climate change. Also, exploring people's experiences of water scarcity and problems they face with their water supply.

I have read the information sheet and understand that

- I can refuse to answer any question, terminate the interview and can withdraw from the research up to a month after the actual interview.
- The researcher will endeavour to keep all information confidential
- My identity will remain anonymous and be protected by a pseudonym unless I state otherwise. I accept that I may be identifiable in the research, even if a pseudonym is used to protect my identity.
- All information collected will remain in a secure cabinet or on a computer that is only accessible through password.
- Information will be used for a Master's thesis, presentations, journal articles.

I understand that the focus group will be audio recorded.

I (your name) …… agree to participate in this research
and acknowledge receipt of a copy of this consent form and the research project information sheet.

_____(to be signed and dated by the participant)

_____(to be signed and dated by the researcher)

Appendix Seven - Semi- Structured Interview Schedule

Semi-Structured Interview Schedule (Nuku'alofa area)Urban

This schedule outlines some of the topics I wish to discuss in the interview. Note that you do not have to answer every question and you are welcome to bring up issues not covered on this schedule.

1) How many people live in your household?

2) What is the main water resource do you have at your household?

3) How do you store water in your household?

4) Who is mainly responsible for managing water in your household?

5) What does climate change mean to you?

6) What are changes you have observed in the water supply in times of drought?

7) How often do droughts occur?

8) Have you experienced any problems with your water supply?

9) How have you coped with water shortages in times of droughts?

10) If applicable, what are the factors that cause a shortage of water supply in your household?

11) Do you have any gardens or plots to help provide domestic supply of food?

Prompt – even small areas with food growing?

- Any land in rural areas?

12) What has happened to these in times of droughts?

13) Do you think climate change is causing water resources to diminish or not? And why?

14) Do you think living in Nuku'alofa/Hihifo affects water demand in your household? Why?

15) In your view, what is the most effective way of ensuring there is sufficient water supply for the household in times of drought?

16) What are your thoughts on climate change and its impacts on the water resources in Nuku'alofa?

17) Do you think the responsibility for ensuring safe water supply is that of the household/community?18) Who else should take responsibility of managing the water supply? And why?

Thank you for participating!

Appendix Eight - Semi- Structured Interview Schedule

Semi-Structured Interview Schedule (Hihifo district) Rural

This schedule outlines some of the topics I wish to discuss in the interview. Note that you do not have to answer every question and you are welcome to bring up issues not covered on this schedule.

1) How many people live in your household?

2) What is the main water resource do you have at your household?

3) How do you store water in your household?

4) Who is mainly responsible for managing water in your household?

5) What does climate change mean to you?

6) What are changes you have observed in the water supply in times of drought?

7) How often do droughts occur?

8) Have you experienced any problems with your water supply?

9) How have you coped with water shortages in times of droughts?

10) If applicable, what are the factors that cause a shortage of water supply in your household?

11) Are there any problems with crop production when there is a drought? What are they?
    a) If so, how does your household cope with these problems?
    b) If applicable, does water scarcity influence crop production in your household?
    c) How important are the gardens for the household?
    d) Can your gardens be made more drought proof? How?
12) Do you think climate change is causing water resources to diminish or not? And why?

13) Do you think living in Nuku'alofa/Hihifo affects water demand in your household? Why?

14) In your view, what is the most effective way of ensuring there is sufficient water supply for the household in times of drought?

15) What are your thoughts on climate change and its impacts on the water resources in Nuku'alofa?

16) Do you think the responsibility for ensuring safe water supply is that of the household/community?

17) Who else should take responsibility of managing the water supply? And why?

Thank you for participating!

Appendix Nine-Semi-structured interview

Members of selected government ministries

1) What is your understanding of climate change?

2) In your view, what are the likely impacts of climate change on the water resources in Tongatapu?

3) What are the anthropogenic and climatic factors that impose threats on Tongatapu's water supply?

4) Do you think climate change is causing water resources to diminish or not? And why?

5) Which sector is likely to be affected the most by climate change? Why?

6) Does your ministry address issues on climate change and water resources? If so, what are they?

7) What is the current government policy in dealing with water scarcity issues?

8) Did your ministry contribute to the Joint National Action Plan on climate change adaptation and disaster risk management? If so, in what way?

9) What have you observed in the water sector in times of droughts?

10) What is your experience of agricultural production in times of drought (when water is limited)?
11) What is your understanding of the PACC Programme conducted in Hihifo?

12) What has your ministry done to address water issues in the communities of Tongatapu?
    a) Do you think this project helps or discourage people's capacity to adapt to water scarcity or water issues in general?

13) What measures/incentives do you think could effectively ensure sufficient water supply in Nuku'alofa?

Thank you for participating!

Appendix Ten - Focus group schedule

Focus Group Schedule (Nuku'alofa areas)

Urban

The schedule outlines some of the questions I wish to discuss when conducting the focus group. The participant is welcome to talk about issues relevant to this study that is not identified in this list. It is my interest to hear about your thoughts on climate change, water scarcity and your experiences in times of droughts with regards to water scarcity.

1) How many people live in your household?
2) What is the main water resource do you have at your household?
3) How do you store water in your household?
    a) Who carries out this task the most?
4) Have you heard of the term climate change? What is your understanding of this term?
5) Do you think climate change influences the availability of water supply in your household/community?
6) Have you ever experienced a shortage in your water supply?
    a) If so, what are the factors that cause a shortage in your water supply? 7) How often do droughts occur?
8) How have you coped with water shortages in times of droughts?
9) Do you buy bottled water in times of drought?
10) What are the challenges you face when coping with water scarcity?
11) Do you have any ideas to improve the water supply system?
12) Are there any problems with crop production when there is a drought?
    e) If so, how does your household cope with these problems?
    f) If applicable, does water scarcity influence crop production in your household?
    g) How important are the gardens for the household?
    h) Can your gardens be made more drought proof? How?
13) Do you think the responsibility for ensuring safe water supply is of the community/household?
14) Who else should take responsibility of managing the water supply? Why?
15) Do you know of any water projects in the Nuku'alofa area?
    a) If so, what are they?
    b) Does having these projects help or discourage people's capacity to adapt to water scarcity or water issues in general?

Thank you for participating!

Appendix Eleven-Focus group schedule

Focus Group Schedule (Hihifo District)

Rural

The schedule outlines some of the questions I wish to discuss when conducting the focus group. The participant is welcome to talk about issues relevant to this study that is not identified in this list. It is my interest to hear about your thoughts on climate change, water scarcity and your experiences in times of droughts with regards to water scarcity and your opinions on the PACC Programme in Hihifo.

1) How many people live in your household?
2) What is the main water resource do you have at your household?
3) How do you store water in your household?
    a) Who carries out this task the most?
4) Have you heard of the term climate change? What is your understanding of this term?
5) Do you think climate change influences the availability of water supply in your household/community?
6) Have you ever experienced a shortage in your water supply?
    a) If so, what are the factors that cause a shortage in your water supply? 7) How often do droughts occur?
8) How have you coped with water shortages in times of droughts?
9) Do you buy bottled water in times of drought?
10) What are the challenges you face when coping with water scarcity?
11) Do you have any ideas to improve the water supply system?
12) Are there any problems with crop production when there is a drought?
    a) If so, how does your household cope with these problems?
    b) If applicable, does water scarcity influence crop production in your household?
    c) How important are the gardens for the household?
    d) Can your gardens be made more drought proof? How?
13) I understand there was a project on water supply in your district/village. Were you a part of this programme?
    a) Was this programme helpful? How?
    b) What are the benefits of this project?
    c) Why do you think this project was conducted in Hihifo and not Nuku'alofa or other areas?
    d) Do you think this project helps or discourage people's capacity to adapt to water scarcity or water issues in general?
    e) What difference did it make before and after the project was completed?
    f) Was it evenly distributed among households?
    g) Do you recommend that the same project be extended to other villages in Tongatapu? Yes or No. Where and why do you think so?
14) Do you think the responsibility for ensuring safe water supply is of the community/household?
15) Who else should take responsibility of managing the water supply? Why?